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May 14, 1948

Science

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(See page 502)

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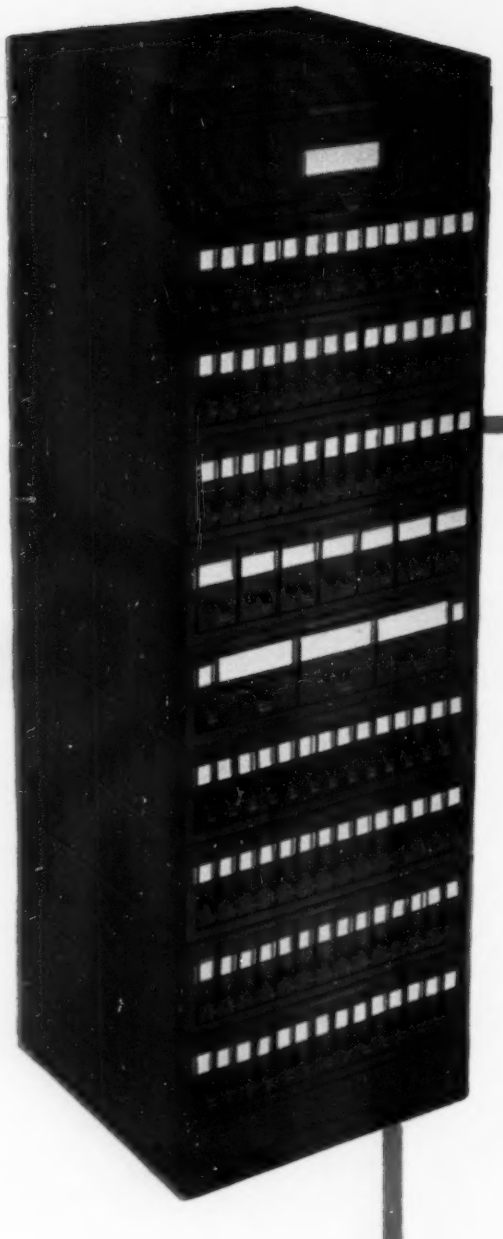

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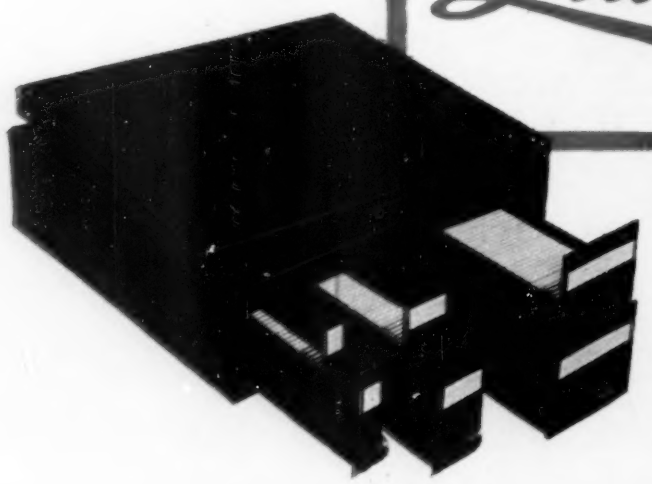

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Some Vital Books in Science: 1848-1947

J. Christian Bay, *Librarian Emeritus,*
The John Crerar Library, Chicago, Illinois

THE GREAT BOOKS OF ANCIENT and medieval times are much more easily pointed out and defined than those of more recent times. The ideological milieus and the historical backgrounds of later centuries—and especially of the century covered by the life of the American Association for the Advancement of Science—are much more complex than those of earlier days. This century has witnessed not only an overwhelming and swift growth in the accumulation of scientific facts and ideas, but also a previously unparalleled development of inductive study and attendant criticism, sifting, and adjustment. These activities have spread themselves so far afield that few among us will venture to follow their development beyond some special subject or geographical area.

Books, and literary production generally, often seem to follow some ecological pattern. They come in natural groups, assembling around ideas and theories that are born, grow into manhood, become senescent, and gradually take their place in history. The best of them help support a tradition without which we should lose a very necessary orientation. Hence, apart from matter written for a temporary or fleeting purpose, no book may definitely be designated as dead. Librarians are aware of the surprising number that are active; they are aware, too, of the frequency with which literature previously overlooked and neglected may be rediscovered and gain new significance.

Some works in every department of literature spring out of life by apparent spontaneity, take their place in the progress of the world, and hold it in spite of time and change. In the field of science we have a few such immortals. These correspond, among books, to the status of a Franklin, a Lincoln, or a Washington, in history. Nothing will dwarf their perennial fame, nor will dust settle upon them. Having been asked to point out some of these monuments of scientific progress which have agitated the minds of our fellows and members during the past 100 years, we take pleasure in embarking upon a bibliological voyage through this centennium of victorious research and thought.

Bridging over the inception of our century are the publications of the Wilkes Expedition, which has been described as making "America's assertion of its scientific coming of age." Most of the authors of these monumental volumes shared in the collective work of the AAAS (J. D. Dana, Horatio Hale, T. R. Peale, John Cassin, Chas. Pickering, Augustus A. Gould, Asa Gray, Wm. D. Brackenridge, E. Tuckerman, Jacob W. Bailey, M. A. Curtis, Chas. Girard, *et al.*). These publications, in quarto and imperial folio, issued in small editions and of limited distribution, reflect great credit upon our Government as well as on the scientists who gradually worked up the large collections assembled in the South Seas and in our own Northwest, and on Cdr. Wilkes himself, who compiled the narrative. This was our first and foremost share in the scientific explorations which later furnished materials for surveys in all fields all over the world.

About 1850, some few scientists who had grown up under the influence of the encyclopedists and afterward shared in some inductive researches during their mature years, felt that a summary of collective view and experience would be useful. Two men attempted this. One was Hans Christian Oersted, whose *Spirit in nature* (1849–50) draws a very clear and charming picture of the coherence of the forces in nature. These survive amidst all changes, and the author considers them expressions of an elemental force, a principle of life connecting organic and inorganic elements. Oersted interpreted thought as the first tangible expression of this principle.

In this respect Oersted went farther than Alexander von Humboldt, whose *Kosmos* first appeared between 1845 and 1849. The history of this great work has for its background the author's practical experience in exploration, geology, astronomy, and even experimental physiology. Nor may we forget that, even while this work was in progress, H. Helmholz (1847) published his small but ponderous book, *Upon the conservation of force.* But *Kosmos* remains the swan song of natural philosophy; its author had taken down notes from the lips of Laplace, Arago, Davy and Wollaston, Bessel and Melloni, and his career was befriended by Sir Joseph Banks, Cavendish, and Herschel. His object in giving *Kosmos* to the world was "to enchain the reader by the contemplation of all that has been attempted during the last 2500 years toward the solution of the enigma of nature and . . . to bring out the resemblances and contrasts in the philosophy of science as developed by Giordano Bruno of the Italian school, by Descartes and Newton."

Humboldt foresaw that his work would soon become antiquated, and, indeed, only a year after *Kosmos* had been brought to a close by his death, the discoveries of spectrum analysis made away with his insistence on a strong separation between cosmic and telluric matter as a mass.

Heat and the constitution of elastic fluids, the extremely important paper by James P. Joule which appeared in October 1848, carried the kinetic theory of gases almost to a recognized validity. From that time on chemical and physical knowledge became interdependent. The Newton-Avogadro–Dalton–Gerhard–Wurtz–Hofmann developments of the atomic theory, brilliantly stated by Roscoe and Harden in *A new view of the origin of Dalton's atomic theory* (1896), and by Mendeléyev, in *The principles of chemistry* (1905), summarized the enormous amount of work which had in the meantime been done with atomic weights, valency, and the Periodic Law.

The *Experimental researches in electricity,* by M. Faraday (1859 and later editions) is one of the catechisms of those working in the fields of physics and chemistry; his *Researches in chemistry and physics* and also John Tyndall's *Floating matter of the air* (1881) are so-called active books, *i.e.* books of asserted widespread and continuous inspirational value. By experiment, Tyndall effectively disproved spontaneous generation of living matter. Faraday opened the door to electrochemistry which, quite apart from its technical applications, assumed large scientific proportions through the work of J. H. van't Hoff and S. Arrhenius.

Another scientist whose collected works, even including short articles, never seem to dwindle in interest is Louis Pasteur. These embrace the wide field from pure chemistry and biology to the industrial arts. Even his limitations of method are illuminating. The field of stereochemistry received from him its first experimental impulse and was expanded by van't Hoff and P. D. Ritchie's *Asymmetric synthesis and assymmetric induction* (1933). Cushny, in his *Biological relations of optically isomeric substances* (1926), also stimulated the extension of Pasteur's stereochemic researches, and thus we come to their application to vital processes, to the genes and their responsibility for hereditary characters and processes—a path logically continuing that of such books as H. S. Jennings' *The universe and life* (1933) and *Genetic variations in relation to evolution* (1935) and supported by the work of W. H. Bragg. L. Karczag's paper on stereogenes as hereditary units (*Z. Indukt. Abstam. Vererb.*, 1927, **43**) draws into consideration Mendel's classical results of variation studies. Much of the study and discussion centering on this problem and on the attendant ones of oxidative processes, enzyme action, vitamins, hormones, etc. may be gathered from Florkin's *Progrès de la biochemie depuis 1940* (1945) and Herman Nielsen's excellent critical work, *Det vitale Princip* (1947).

The subject of radioactivity brings to mind Rutherford's *Radioactive substances and their radiations* (1913). The chemical phase is represented by Madame Curie's *Radioactivité* (1935); the physical, by R. A. Millikan's *Electrons* (1936). Study of the atomic nucleus by N. Bohr (his *The theory of spectra and atomic constitution* appeared in 1924) and his school has been in progress since 1913 and has led to a profusion of publications, subsidiary discoveries, and inventions which are of use in medicine and in industry.

The crown of modern spectroscopy was the discovery by W. C. Röntgen, in 1895 (Verhandlungen der Physikalisch-Medizinischen Gesellschaft in Würzburg), of an invisible and very penetrating radiation later designated as X-rays.

The study of electromagnetism, the existence of which was recognized gradually, was greatly promoted by Thomas A. Edison's discovery of what is known as the Edison Effect (1884). In due course (1907) L. De Forest developed the three-electrode tube, based on H. E. Hertz's production of electromagnetic waves (*Wied. Ann.*, 1888, **34**; *Gesammelte Werke*, Vol. 2). These discoveries found their corollary in the invention of radio communication (from Europe to America in 1915), with which Guglielmo Marconi's name is linked.

Other phases of chemistry-physics, progressively pursued, have given rise to works which have been worn out time and again in libraries as the result of admiring use. Such are those of Sir J. J. Thomson, Lord Kelvin, Nef, Sir James Jeans, L. Pauling, W. G. Palmer, and J. Perrin.

In 1925 Bertrand Russell gave us his *ABC of relativity,* which does not fail to illumine Albert Einstein's numerous papers and his great summary, *Relativity, the special and general theory* (1920; original, 1919), probably the most discussed and commented upon scientific clairvoyance of the present century.

The registration phase of chemical compounds called forth J. W. Mellor's *A comprehensive treatise on inorganic and theoretical chemistry* (16 vols., 1922–37) and Beilstein's *Handbuch der organischen Chemie.* A not less gigantic undertaking is the *Chemical Abstracts,* organized with manifest success and continued since 1907.

The scientific exploration of the United States was begun in the '50s, largely under the auspices of our War Department, whose corps of engineers, fortified

by scientists and collectors, produced a long series of excellent official reports embodying studies in all pertinent fields, particularly of the trans-Mississippi country. A large number of our foremost scientists participated both in these expeditions and in the study of the collections and results obtained. The *Reports of explorations and surveys to ascertain the . . . route for a railroad from the Mississippi River to the Pacific Ocean,* published by the War Department from 1855 to 1860 (12 vols. in 13), are a lasting witness to these excellent activities. Incidentally, it may be pointed out that our western and mountain landscapes never again can be portrayed as they were then by the tinted lithographs and engravings in these Wheeler Reports and the special monographs of the same period. Such work reflects great credit on our pioneer scientists and on our Government.

This internal exploration gave impetus to John James Audubon's studies in natural history. The famous bird books pertain to an earlier time, but Audubon and Bachman's *The quadrupeds of North America,* especially the edition of 1849, also remains a classic in our literature.

It is impossible to enumerate more than a few of the collecting journeys and the scientific expeditions that have visited all parts of the world in the last 100 years. Humboldt's journey in the equinoctial regions of South America was an example, as, indeed, were the later local explorations by P. W. Lund. Eminent are the accounts of the explorations in the Amazon River valley by A. R. Wallace, recorded in his *Narrative of travels on the Amazon and Rio Negro* (1848–52; published in 1870) and *Palms of the Amazon and the Rio Negro.* His companion, H. W. Bates, wrote his exemplary *The naturalist on the River Amazons* (1848–59; published in 1863). In the northern part of the same continent, explorations were pursued by Richard Spruce, who wrote *Notes of a botanist on the Amazon and Andes* (2 vols., 1908), and by Robert and Richard Schomburgh, authors of *Travels in British Guiana* (Engl. ed., 1922), whose expeditions resulted in important discoveries of strange forms of life, such as the *Victoria regia.* All these journeys happily were performed before the advent of the industrialists, as was that of Thomas Belt, whose animated account, *The naturalist in Nicaragua* (1868; published in 1847), served many followers. Of even more importance is J. D. Hooker's *Himalayan journals* (1854), which impressed deeply the whole of the cultured world. The travels of Livingstone (1857), although for a different purpose, for some time agitated everyone. Wallace's *Malay Archipelago* (1870) and *Naturalist's wanderings in the Eastern Archipelago,* by Henry O. Forbes (1885), are models of appealing, though unconscious, adventure. Thus, by degrees the world became not only circumnavigated and explored but somewhat known. Among the expeditions conducted on a very large scale may be mentioned that of the "Challenger," voluminous reports of which were published from 1880 to 1895; the "Erebus" and "Terror" voyages; those of the "Beagle," in which Hooker and Darwin, respectively, took part, and of the "Rattlesnake" (Huxley); the later "Belgica" and "Siboga" expeditions; the "Ingolf" and sundry other arctic voyages; and the Princeton Patagonian Expedition. The long-continued exploration of Greenland under Danish auspices, recorded in the *Meddelelser fra Grönland,* is as exemplary as the activities at Woods Hole (C. O. Whitman), Cold Spring Harbor, Dry Tortugas, Puget Sound, etc., and at the Furesö Fresh Water Laboratory (Wesenberg Lund). The long-continued, persistent search for the Earth's poles certainly has benefited geographical research and terrestrial physics as well as geology and paleontology. It should be noted that, while Nordenskiöld accomplished the Northeast Passage, not only the Northwest Passage but also the first location of the North and South Poles were achieved by one man, R. Amundsen. Among modern books of scientific travel, probably the most deservedly popular is William Beebe's *Galapagos* (1924). By-products of Hooker's journey in India were his magnificent *Illustrations of Himalayan plants* (1855) and *The rhododendrons of Sikkim-Himalaya* (1849–51).

A. R. Forsyth has pointed out that one of the most interesting phenomena in the field of mathematics is "the increase in the number of subjects apparently dissimilar from one another, which are now being made to use Mathematics in one form or another." Somewhat responsible for this was George Boole, whose famous *Laws of thought* was published in 1854. The method has, however, entered practically every science and its application. This would be somewhat in accord with Benjamin Peirce's definition of mathematics as "the science which draws necessary conclusions," except that conclusions, and the necessity for them, vary with the changing times. Bertrand Russell, as we know, supplied varied definitions, serious or eristic, but all seem to agree that logic is a necessary element in any tangible and applicable definition. G. Cantor once asserted that in mathematics the art of properly stating a question is more important than its solution—a thesis that has been applied, with modification, to medicine; but apart from professional scholars, most intelligent persons of logical bent have been content to exercise their abilities on one of the many books of problems, e.g. the excellent, often reprinted *Mathematical recreations and essays,* by W. W. Rouse, or to peruse Bertrand Russell's *Principles of mathematics* (1903) or C. J. Keyser's *The human*

worth of rigorous thinking (1916). H. G. Grassmann's *Lineare Ausdehnungsehre* (1844–62 and 1877), which remains a classic for geometric applications, algebraic functions, and calculus, was supported by R. Hamilton's *Lectures on quaternions* (1852), the field being further developed by Benjamin Peirce.

The general theory of imaginary points, lines, and planes was elaborated by K. Van Staudt in 1856–60, but remained scantily recognized until its application was made clear by Reye in 1868. The graphic representation of imaginaries came nearly 20 years later.

In 1864 Karl Culmann published his epoch-making work, *Die graphische Statik.* In pure geometry we have D. Hilbert's *Grundlagen* (1930) and his *General theory of linear integral equations,* Klein's work on the theory of automorphous functions, Doetsch's *Theorie und Anwendung der Laplace-Transformation* (reproduced in 1943), and the papers by C. Jordan, E. Picard, and C. J. de la Vallee-Poussin. All this and more, important to the mathematical thinker, somewhere and somehow has found wide application in astronomy (Newcomb and others), in problems in mechanics, motion, sound, light and heat, electricity and potential, and this brings us to the present era of relativity and its influence through Einstein and his school. Einstein's far-reaching work marks a new era in several sciences. H. Minkowski's elaboration, in his *Raum und Zeit,* probably has won as much favor as any book in measuring the potential philosophy of this system of research.

Astronomy, a favorite among sciences since ancient times, broke in upon our special century by the first photograph of the moon taken by Bond in 1850. Since then, public interest has followed the researches through such books as Spencer Jones's *General astronomy* (1934), Shapley's *Flight from chaos* (1930), Lowell's book on Mars (1909), and Pickering's *The moon* (1903). The greatest praise is due the long series of *Science* and of *Popular Science Monthly* for following up new discoveries and hypotheses, the work of Clerk Maxwell, Schiaparelli, Lockyer, Draper, Michelson, Barnard, and many others. We should also note here the widespread popularity of such excellent books as Serviss' *Astronomy with the opera glass,* R. A. Proctor's *Half hours with the telescope* (1925), and Harvey B. Lemon's *From Galileo to the nuclear age* (1934), the last-named book being a blessing to the undergraduate and the layman.

Similar widespread attention has attended such works as Henry N. Russell's *The solar system and its origin* (1935). It has been said that the latter, apart from its factual worth, helps take man's interests away from himself and into an ideal sphere. In addition, such books as R. A. Millikan's *Protons, photons, neutrons and cosmic rays* (1935), J. L. E. Dreyer's *Planetary system* (1906), and, from the historical standpoint, Norman Lockyer's *The dawn of astronomy,* create a healthy taste for working at the "riddle" of the universe; and in this respect the researches of Niels Bohr hold the same rank as the observations, centuries ago, of Tycho Brahe, and as the study of Mars by David Gill in 1877.

In 1858 a combined communication from Charles Darwin and Alfred Russel Wallace, who was the joint discoverer with Darwin of the principle of natural selection, was read to the Linnean Society in London. This introduced to all the world the fact that the dogma of the immutability of species was in doubt.

In 1859 came Charles Darwin's *Origin of species.* In itself, it was epoch making and gave rise to waves of new departures in many fields of thought. Historically, the work constitutes a climax of composite effort more than a sudden eruptive stroke of genius, as, indeed, the author modestly urged. Nor should it be considered without reference to Darwin's *Animals and plants under domestication* and, for educational value, his experimental work in zoological, botanical, and geological fields. Sir Charles Lyell inspired much of Darwin's geological conclusions. Wallace, as we know, shared in the original idea, as did Joseph D. Hooker in its development and Thomas H. Huxley in the explication of the theory. The best account of the immediate Darwin period is found in George J. Romanes' *Darwin and after Darwin* (1892–97). J. D. Hooker's two classics, the introductions to his *Flora of New Zealand* (1853) and to the *Flora of Tasmania* (1859), voiced great advances in the topographical study of plant distribution. In this connection, A. R. Wallace's *Island life* (1880) should be mentioned. Among these more elaborate researches and theories we must not overlook the *First principles* (1860–62) of Herbert Spencer, which served as the beginning of his system of philosophy.

The latest edition of the *Klassen und Ordungen des Tierreichs,* by H. G. Bronn, having proved somewhat to be a Tower of Babel, zoologists have been grateful for *The Cambridge natural history,* by S. F. Harmer and F. E. Shipley, and for the British Museum Lists, often veritable monographs on large and small groups, orders, or families. In embryology and cytology, F. M. Balfour, C. S. Minot, and E. B. Wilson have given us veritable classics, and in eugenics C. B. Davenport's *Heredity in relation to eugenics* seems to remain unsurpassed. W. S. Kent's *Manual of Infusoria* (1880–82) and Joseph Leidy's *Fresh-water rhizopods* (1879) mark great eras in their field. In the general field of biological research, Abderhalden's *Handbuch der biochemischen Arbeitsmethoden* (9 vols., 1910–19)

and *Handbuch der biologischen Arbeitsmethoden* (106 vols., to 1939) conceive their scope as being very broad, and the latter has grown into a publisher's convenient outlet for enormous monographs on limited subjects, all very useful and some even unique in their fields.

The plankton literature (Wesenberg Lund and others) since the beginning of this century has grown into a department by itself.

In special systematic zoology there has been in every country a profusion of excellent descriptive, often artistically illustrated monographs. Outstanding among these (apart from Audubon's works) are Rex Brasher's *Birds and trees of North America* (12 vols., 1929–32) and Wm. L. Dawson's *The birds of California* (4 vols., 1923). The instinct for accurate detail and the artistic skill of the painters, J. G. Keulemans, L. A. Fuertes, and H. Grönvold, has been a boon to many ornithologists. On the whole, art as applied to natural history deserves some special research and study. Artist and author met most effectively in the exquisite and rare work, *Illustrations of the nests and eggs of the birds of Ohio* (1879–86), by Howard E. and Nellie Jones, and in the various monographs by Daniel G. Elliot, notably those on the grouse (1864–65) and the pheasants (1870–72) and his *Birds of paradise* (1873); many of the exquisite plates in Elliot's works were drawn by J. Wolf. Since ornithology has become an important link in that conservation of natural forms of life on which the world depends somewhat, we cannot avoid mentioning Wm. Beebe's *Monograph of the pheasants* (4 vols., 1918–22); E. L. T. L. Schiöler's *Danmarks Fugle* (3 vols., 1925–31); W. W. Brabourne's *The birds of South America* (2 vols., 1913–17); the truly illustrious *History of the birds of Europe* (8 vols., 1871–96), by H. E. Dresser; J. Gould's monumental illustrated monograph, *A century of birds from Himalaya* (1832) and *The birds of Europe* (1832–37); his monographs of the toucans (1833–35), the trogons (1836–38), the humming-birds (5 vols., 1849–61), and the partridges of America (1844–50); his *Birds of Australia* (1840–69); *The birds of Asia* (7 vols., 1850–83); and *The birds of New Guinea and the Papuan Islands* (5 vols., 1875–88). Special monographs on the avifauna of Laysan (and the Hawaiian Islands) by L. W. Rothschild and of Spitzbergen by A. F. Koenig deserve mention. Of very special interest in wide circles is J. G. Millais' *The natural history of the British surface-feeding ducks* (1902) and *British diving ducks* (1913). Also of quite universal and popular value and esteem is T. G. Pearson's *Birds of America* (1917 and later).

The monographs and the systematic catalogues published for many years by the British Museum, e.g. the *Catalogue of birds* (27 vols., 1874–98), have earned deserved high reputation. The same is true of the series, *Biologia Centrali-Americana,* edited by F. D. Godman and O. Salvin.

Ichthyology is well represented in George Brown Goode's *Oceanic ichthyology* (1895) and in the same author's very comprehensive work, *The fisheries and the fishery industries of the United States* (5 vols. in 7; 1884–87).

General attention deservedly has been attracted to the monumental work edited by P. Wytsman, the *Genera insectorum* (1902–31). Among the internationally known books devoted to special groups, we should mention J. H. Fabre's *Souvenirs entomologiques* which have attracted world-wide attention. Also excellent in their fields are W. M. Wheeler's *Ants, their structure, development and behavior* (1910) and G. W. and Elizabeth G. Peckham's *On the instincts and habits of the solitary wasps* (1898). Many outstanding general and special works on butterflies are available, among which we find at least two notable American ones, Samuel H. Scudder's *The butterflies of the eastern United States* (3 vols., 1889), and Sherman F. Denton's *Moths and butterflies of the United States* (3 vols., 1900; also an expanded edition of wider geographic scope, 12 vols.).

We may refer here also to Darwin's *The formation of vegetable mould by the action of rain worms* (1881)—an extraordinary accomplishment.

With great modesty and exemplary persistence, G. W. Tryon and Henry A. Pilsbry began publishing in 1879 their renowned *Manual of conchology,* of which 26 volumes had been published up to 1921. To Wm. S. Kent we owe an important description, *The Great Barrier Reef of Australia* (1900); and to Wm. Beebe, an inspired volume on the Sargasso Sea (1926), under the title *The Arcturus adventure.*

Consideration of F. A. Michaux and Thomas Nuttall's *The North American Sylva* (5 vols., 1865), and especially of Charles Sprague Sargent's *Silva of North America* (14 vols., 1891–1902), reminds us that such monumental works on general and special subjects in natural history definitely showed that America had "come of age." Denmark and France have excelled in copper engraving (*Flora Danica,* 1761–1883, and the oceanographic monographs from Monaco); England and Germany, in lithography (Hooker's *Icones Plantarum*; Curtis' *Botanical Magazine*; *Flora Brasiliensis,* 1840–1906) and in woodcuts. Among our many achievements in this field J. N. Rose and N. L. Britton's *The Cactaceae* (4 vols., Carnegie Institution, 1919–23) should not be forgotten. In British forestry, Lambert's *Description of the genus Pinus* deservedly ranks as a classic.

The flora of North America, by N. L. Britton and A. Brown, came in as a relief to many working botanists and laymen, as did the many works of L. H. Bailey on flowers and gardening. Asa Gray's various textbooks, as well as the more modern ones of C. E. Bessey and others, have been most useful in building up fundamentals on which thousands of students and hundreds of special investigators have counted for proper understanding of the rapidly growing science. Taxonomic botany is responsible for many excellent local flora and for a profusion of monographs, such as J. W. Harshberger's *Maize: a botanical and economical study* (1893), Wm. Trelease's *The American oaks* (National Academy of Sciences, 1924) and *The genus Phoradendron.* Trelease also edited the *Botanical works* of George Engelmann (1887). Edwin Hale Lincoln, in 1910–14, photographed the wild flowers of the United States in their natural habitats; Harry Detjen, those of the State of Washington (1939–40), botanically identified. Lindley and Ravenscroft's *Pinetum Britannicum* (3 vols., 1884) remains a grand local monograph. Of the same class is E. H. Lincoln's *Orchids of the north eastern United States* (2 vols., 1931).

In systematic botany De Candolle's *Prodromus* was succeeded in England by Bentham and Hooker's *Genera Plantarum* (1862–83), which gave rise to the *Index Kewensis*; in Germany the natural system, developed by A. Engler, took form in the collective work, *Die natürlichen Pflanzenfamilien* (1887–1900). In economic botany, among a profusion of practical works, L. H. Pammel's *Manual of poisonous plants* (1910–11) and *Honey plants of Iowa* (1930) are preeminent.

Although plant geography depended for its initial growth on the natural history surveys of the various parts of the world, it leaned closely to physics and meteorology until Warming, in his *Plantesamfund* (1895; Engl. ed., 1909) and in his monograph, *Lagoa Santa* (1892), applied biological and ecological principles to the analysis of plant distribution and, with a world-wide following, notably by the aid of W. Schimper, created a new and rational view of plant distribution. Schimper's *Pflanzen-Geographie auf Physiologischer* (1898; Engl. trans., 1903) remains a basal work.

The modern program of plant physiology was set by Julius Sachs in his *Experimentalphysiologie der Pflanzen* (1865). An American classic in this field is Daniel T. MacDougal's *The influence of light and darkness upon growth and development* (1903).

Bacteria in relation to plant disease (3 vols., Carnegie Institution, 1905–14), by Erwin F. Smith, remains a peer in its field, and we recollect with deep respect the work of W. G. Farlow, George Atkinson, B. J. Galloway, L. H. Pammel, and J. H. Macbride. In general mycology we have P. A. Sarcardo's *Sylloge Fungorum* (22 vols., 1882–1913). The science of bacteriology falls entirely within our period. It is impossible to say which of Pasteur's three larger books attracted the greatest attention—his *Études sur les maladies des vers à soie,* his *Études sur la bière,* or his *Études sur le vin*—but all three dwindle when compared with some of his laconic communications, which ranged from the subject of vinegar to the use of attenuated viruses in the cure of rabies and other infections. Nor did Koch's papers on splenic fever, tuberculosis, etc., as well as those of the younger school (Klebs, Loeffler, Roux, and Ehrlich) fail to stir the entire world, learned and lay. Easily the most outstanding of all works on economic bacteriology is Hellriegel and Wilfarth's *Untersuchungen über die Stickstoffnahrung der Gramineen und Leguminosen* (1888), which opened our knowledge to the fundamental supply of nitrogen for the production of protoplasm in plant organs by bacterial action. This subject has been treated in a masterly manner by Fred, Baldwin, and McCoy, in their monograph, *Root nodule bacteria and leguminous plants* (1932), an American classic.

The epoch-making discovery of a method of producing pure cultures of microorganisms from single, identified cells was communicated by E. C. Hansen in 1882–86 in the *C. R. Lab. Carlsberg.* Scarcely less remarkable was H. Marshall Ward's biological analysis of the component organisms of the ginger-beer plant and his successful reuniting of these components in reconstructing the symbiosis (*Phil. Trans. roy. Soc. Lond.,* 1892, **183**) by biological synthesis.

In comparative physiology, apart from important studies of single phenomena or functions, the fundamentally important work is Claude Bernard's *Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux* (1878), in which was proclaimed the principle that there is but one kind of life, one physiology embracing all living beings. This was practically asserted by Jacques Loeb in the two volumes comprising his widely scattered papers, published in Chicago in 1905 under the title *Studies in general physiology,* which deal largely with induced movements. To these may be added Paul Bert's famous (and yet but recently translated) *La pression barométrique* and the several works of Jagadis Chunder Bose, of India, on bioelectric phenomena and involuntary impulses; these researches indicate a perfection of research method quite unique and different from Western experimentation.

The cell as a unit had been identified before our era, but protoplasm had indeed been recognized long before Purkinje and Von Mohl named the substance,

and the identification of animal and plant protoplasm was proved by Max Schulze, in a paper printed in the *Archiv für Anatomie und Physiologie* in 1861. Th. Schwann, in his famous *Microscopic researches,* had parallelized the animal with the vegetable structures and recognized the nucleus (discovered by Robert Brown in 1831), but not the medium within the cell. After 1861, and when chemical stains were used on microscopic structures, chromosomes were discovered, and with them began the study and philosophy of inherited characters, which brings us to August Weismann's *The evolution theory* (1904).

Two other publications, Gregor Mendel's *Versuche über Pflanzenhybriden* (two papers, 1865 and 1869, available in several editions) and Hugo De Vries' *Die Mutationstheorie* (1901–03), are founded on studies of plants and supported by statistical methods. Francis Galton, in his *Natural inheritance* (1889), indicated perfected methods later used by W. Johannsen and others. The wide publicity of these studies and their application in many fields made these works widely known. Mendel's hybridization experiments, forgotten by his contemporaries and rediscovered by De Vries, showed that ripe germ cells will produce the pure character of only one parent or of the other. De Vries' experiments showed that new modifications will occur suddenly and will account for permanent variation if they breed true. These new forms are his mutations and are considered subject to, but not evoked through, gradual selection. We should not, however, overlook T. H. Morgan's *The mechanism of Mendelian heredity* (1915). Here also belong Øjvind Winge's recent studies of hybrids developed from traditional pure cultures of yeast (*C. R. Lab. Carlsberg*).

While the atomic theory continued to develop, the molecular unit of organic bodies was ingeniously explained by C. Nägeli, in his excellent work, *Die Stärkekörner* (1858). Starch is the first visible product of photosynthesis, and Nägeli studied several thousand forms. Quite as important was his theory of the growth of these bodies, by apposition and by intussusception. Although this does not fit all cases, as Arthur Meyer (1895) and others showed, it still remains satisfactory, even for membranes.

The biographies of the men and women who have given their lives to the progress of science afford in many ways the cultural background on which our composite picture is drawn. Each has his specialty, each student his favorites. There is abundant inspiration in this biographical literature.

In conclusion, the following works, which are of fundamental importance to any student of the history of science, are noted: Walter Libby's *Introduction to the history of science* (1917); George Sarton's *Introduction to the history of science* (1927) and *The history of science and the new humanism* (1937); and Lynn Thorndike's *A history of magic and experimental science* (6 vols., 1923–41).

The Development of Scientific Publications and Their Importance in the Promotion of International Scientific Relations

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INTERNATIONAL RELATIONS IN SCIENCE may be promoted in many ways. Before discussing some of these, however, we should have before us a clear idea of the aims of international scientific cooperation. If we consider the major issues only, we may define the principal aims as:

(1) The exchange of information, whether scientific, professional, or practical, in such a way that it will be available to anyone who can profit by it.

(2) The attainment of objectives which individuals or scientists of a single institution or nation cannot accomplish. These objectives may be projects in the field of pure or applied scientific research, they may be cooperative, scientific, or practical publications, or they may be objectives of a more general or methodological nature.

(3) The formation of an *esprit de corps* which may, at least at some times and at some places, counteract the evils of human international politics and contribute to the establishment of a commonwealth of nations.

The means by which these aims may be approached include: (a) various forms of cooperative research, (b) international conferences and congresses, (c) the activities of international commissions and committees responsible for the solution of specific problems—often problems of a practical or methodological nature, (d) personal contacts, visits, and correspondence, (e) exchanges of research materials, specimens, literature, etc., (f) exchanges of professors, research workers, and students, and, last but not least, (g) various publications. In this particular case we find that there are a number of possible types to be considered.

Scientific Journals

After the invention of printing, in the 15th Century, which contributed more than any other single factor to the promotion of international scientific relations, scientific material was published in book form or, very rarely, on a broadside. Scientific journals did not exist until the middle of the 17th Century. It is useful and interesting to follow the origin and development of these journals. Their origin, it appears, is clearly connected with the origin and development of scientific societies.

Scientific academies, *i.e.* publicly recognized scientific societies with a limited membership, the members of which often received some salary or a pension, were established in Italy about 1560. Then followed the founding of the Academia Naturae Curiosorum in Vienna in 1651, the Académie des Sciences in 1666, and the Collegium Curiosum in Germany in 1672. The Royal Society of London had been established since 1660 and began its *Philosophical Transactions* in 1665. General scientific societies, in which a membership could be obtained more easily, found their origin, of course, in the academies but did not flourish until the number of scholars increased in the late 18th and early 19th Century. The Linnean Society of London was founded in 1788 and began its *Transactions* in 1791. The *Transactions* of the American Philosophical Society, which was established in Philadelphia in 1744, have been published since 1771. Migratory societies which meet each year in a different town have been popular since the establishment of the Gesellschaft deutscher Naturforscher und Ärzte in 1822, the British Association for the Advancement of Science in 1831, and the AAAS in 1848. These were soon followed by international congresses and societies; in the biological field one of the first international meetings (1864) was devoted to horticulture.

During the Middle Ages and the Renaissance most scientific research was done on a very individual basis. Later, as Martha Ornstein outlines in her classic book *The rôle of scientific societies in the seventeenth century*, the function of the new scientific societies was "really twofold; they created laboratories and observatories and did a great deal to encourage original work; but they often, in addition, undertook to publish, periodically, news of the work done under their auspices, and often the work of other learned men, in order to make it known as quickly and as widely as possible. . . ." "The only means," Ornstein continues, "of scientific intercommunication in the early seventeenth century was private correspondence. Hence the great significance of such men as Mersenne, Peiresc, Collins, and Wallis, who kept up a voluminous correspondence, and the necessity that such scientists as Huygens and Boyle should be in personal con-

munication with other scientists. The unreliability of this form of communication is self-evident. It depended too much on friendly or hostile feeling, and at times on geographical contiguity. The numerous quarrels regarding scientific discoveries, as for instance between Torricelli and Pascal, Newton and Leibniz, Hooke and Huygens, best prove the insufficiency of such informal intercommunications. In order to secure priority while keeping discoveries secret, ciphers were used. The right road to a solution of all these difficulties was clearly indicated when Denis de Sallo published in 1665 the first volume of the *Journal des sçavans*. . . . It proposed, first, to give a catalogue and short description of books; second, to give obituaries of famous men and summarize their works; third, and most significant for us, the prospectus proclaims that the *Journal* will publish experiments in physics and chemistry which serve to explain natural phenomena, new discoveries in arts and sciences, useful machines, curious inventions of mathematicians, observations of the heavens, meteorological phenomena, and new anatomical findings in animals. The fourth point of the program was the publication of the principal decisions of tribunals and universities; the fifth, of current events in the world of letters." One will note that this early scientific magazine differs quite a little from most of today's scientific journals. It was almost more a newsletter or a *Fachblatt* than a scientific journal and clearly patterned on contemporary newspapers (newspapers were not common until after the early 1600s).

The *Journal des Sçavans,* which, of course, had a few forerunners, was soon followed by a variety of other scientific journals, some of them, as briefly outlined above, issued by the Academies and others by individuals or booksellers. Several of these journals reported primarily on the scientific activities and researches of the members of the Academies; others, often with the word *Correspondence* or *Korrespondenz* in the title, were newsletters with an intriguing, constantly changing scheme of contents—journals in which an enormous amount of historically valuable material remains hidden. When preparing entries for the Index Botanicorum, I often deplore the lack of good cumulative indices to most of the early scientific journals, feeling that more details about many colleagues of the past must be available in contemporary scientific journals. In fact, many data on Linnaeus' early life, directly copied from "releases" which he sent to the editor, were discovered nicely printed in the *Hamburgischen Berichten von neuen gelehrten Sachen* (1732 et seq., reprinted by Bryk in 1919)!

Several of the scientific journals of the early 1800s still look very much like the newsletters of the 17th and 18th Centuries. Though some of them are chiefly or entirely devoted to reports of the results of original work, many others devote much space to news, abstracts, personalia, letters, quotations from, or reprints (often in translation) of, materials published elsewhere. Many early 19th-century journals contain material of the sort published today in such journals as *Science* and *Nature* or in such professional news journals as *Chemical and Engineering News* rather than in our regular scientific journals. Since the middle of the past century most scientific journals have devoted their columns almost entirely to original scientific contributions with a sprinkling of biographical notices, discussions of the aims and scope of research in certain fields, reviews of recent advances—not to speak of polemics, which were so common one or two generations ago—etc.

During the past 100 years the number of scientific journals has increased manyfold. Many of the new journals are no longer devoted to an entire branch of science, as zoology or chemistry, but concentrate, with the increase of scientific specialization, on a limited field, e.g. ornithology or colloid chemistry. During the late 19th and the present Century we find an increasing tendency among scientific journals to concern themselves with only very limited subjects, subjects often narrower than the specialism of the average individual worker. Generally speaking, the biological journals tend to fission more than those in the chemical and physical field.

The Modern Scientific Journal

The modern scientific journal offers a number of problems to its readers or, rather, to its authors and editors which were unthought of one or two generations ago.

For almost a century, the production costs of scientific journals have increased approximately in the same ratio as the number of subscribers. The increasing number of subscribers found in such *terrae novae* as North America, Russia, and Japan contributed much to the development of continental scientific journals. In recent decennia the existence of many journals has been possible only by the backing of a society or a university or by the income from advertisements. Specialized journals which do not have such support often operate at a loss and cause their sponsors many difficulties. At one time the prices of continental, particularly German, journals were absolutely and relatively so much higher than those of journals published elsewhere that an organized action of North American librarians was needed to force prices down.

It would be interesting to compare the way in which the average scientific journal was read a century ago with today's modus of use. A hundred

years ago the average worker in the natural sciences (often a physician by training or profession) found in almost every natural science journal much that he could read with profit and pleasure. Today we approach our journals, either via the abstracting journal or by glancing through the table of contents, and quickly copy on an index card whatever seems essential. Many scientists have now lost the reading habit to such an extent that the few good general news and review journals, as one may observe in any large institutional library, are often only hastily scanned for material in the user's immediate department.

Much has lately been said and written about the editing of scientific journals. Some authors feel that their papers should be published exactly as presented, whereas certain editors want to make all contributions uniform, not only as to typography (which seems desirable under all circumstances) but also as to style and internal matters. During these heated discussions it is often forgotten that there is a difference between journals open for the publication of papers on any subject in a certain field and journals the editors of which endeavor to obtain chiefly papers on subjects specified by them, making their journals more into a series of symposia than into a collection of transactions. Journals of the latter type will be read more widely and will necessarily need a more exacting editing of their contents than journals which serve only as an outlet for the writings of those who are entitled to use them as a medium of publication.

Even those who are only slightly familiar with the history of science know that the majority of great, original workers published during their lifetime only a limited number of papers, often chiefly extensive memoirs and a few books. This, most certainly, does not mean that there were not many others, just as great, who produced a stream of papers, almost each of them a gem and a real contribution to the advancement of science. On the other hand, many less important workers, who really do not contribute substantially to the advancement of science, pour out a steady stream of articles and cover another's desk with an amount of print which must often be embarrassing to the editors of the journals which are somehow called upon to publish it. There should be freedom in the world of science, yet it seems very desirable that we teach our students early that one good original memoir, or one careful essay or discussion, or one good book may be worth a dozen small communications, and that the number of one's writings can and should never be a yardstick of one's stature. Unfortunately, all over the world, there exist today factors in academic life which lead to the habit of publishing a great many small papers.

From time to time these and other problems have been surveyed by individual colleagues or special committees. In this connection some mention may well be made of Wellensiek's studies of publication problems which, undertaken shortly before World War II, did not find the attention they deserve. In a number of papers based on an analysis of all botanical articles published during 1930 and 1934 (but not referring only to botany), Wellensiek suggests that certain changes seem desirable in the modus of publishing scientific material and in the publishing behavior of scientists. In a report presented at the 6th International Botanical Congress, he suggested that some useful changes might be proposed by an international committee after a thorough study of the problems involved. This met with opposition, because certain scientists felt that they would not be able to publish in the future as much and as freely as they had been able to do. This, however, was not the idea. Wellensiek's proposals called chiefly for a study of the manner in which research data are presented for publication, a study of the language problem (he suggested English as an exclusive scientific language), a certain standardization of the format and modus of printing of journals, the need for a register of all scientific journals (with suitable subject and geographical indices), a study of the way in which individual articles are presented in journals, with special reference to the title, author's name and address, mention of date of publication, table of contents, literature citations, reprints, etc.

Publications containing reports of original research remain the oldest and most important way of contributing not only to science itself but also to international scientific relations generally, in which every scientist takes part whenever he has an article published. This also is almost the only form of international cooperation which is continued to a considerable extent in times of turmoil and war.

When those concerned with such things consider the promotion of international relations through publications, they often take original scientific publications too much for granted, as one will notice from the reports and resolutions of certain recent international conferences. This is not as it should be; also, in this field there are specific international problems and possibilities. I believe one of the great possibilities to be the establishment of large, international, scientific journals. In biology, for instance, we have many international journals, but almost all of these are small journals with a limited scope and therefore, in spite of their world-wide circulation, of a much smaller circulation than certain of the leading national biological journals. Yet there seems to be quite a *raison d'être* for journals which could publish short, somewhat important material quickly, journals which could bring

out 100–200 articles in one monthly number and which, as a result of their truly international character and scientific importance, could easily obtain such a circulation that they could be made available much more cheaply than the average journal. Whenever I see a number of the fine *Journal of the American Chemical Society,* I cannot help feeling that we could produce something of this kind in the less opulent branches of science by international cooperation.

The type of journal I have in mind has, in biology, been approached perhaps most closely by the *Journal of Economic Entomology.* Noteworthy in this journal is the space- and time-saving separation of longer articles and brief communications. At the end of each issue some space is given to the discussion of professional problems or important news.

Scientific News Journals

No effective international cooperation, in any field of science, is possible unless one is well informed about what is going on in the world of science. Some scientists feel satisfied if they keep themselves informed on scientific progress. In addition to our regular, modern scientific journals and our general scientific news journals, such as *Science* and *Nature,* we need specialized journals devoting all or most of their space to the publication of intelligence concerning the activities and plans of scientists, scientific institutions, and scientific societies, discussions, announcements, requests, notices, and other types of special documentation, rather than to the results of research. It takes scientists as well as *objets d'étude* to make science. For example, more than 2,000 journals are at present devoted to plants, yet only very few of them contain news and information of the kind referred to above. Linnaeus devoted much of his *Philosophia Botanica* to information of this type. The modern worker, oddly enough, often forgets that plants alone cannot yield a grain of botany.

I have done much experimenting along these lines in biology and believe that in that field we badly need an international, monthly or biweekly, professional news journal consisting of review articles, discussions, international and national news, personalia, book reviews, and similar material, as outlined in Dr. Merrill's and my report to the National Research Council's International Relations Committee in 1944. Last year I experimented with a very inexpensive, concise newsletter, *Biologia,* which emphasized international biological affairs, with the typical four-page format of many early English and Colonial American newspapers. This greatly appealed to those directly engaged in international relations work and similar activities but did not give the average working scientist too much of interest or stimulation.

Reviews of recent advances can perhaps be published most usefully in scientific news journals in order that they will be read well and widely. Since the second part of the 18th Century quite a few journals have specialized in review articles. Sometimes they deal with the past year's progress, but for the most part they are concerned with advances during the past few years and occasionally, as in the case of the excellent *Reviews of Modern Physics,* which might well be imitated in other branches of science, with progress during a much longer period. These review journals have lately been issued often as yearbooks of the now well-known annual review and *Fortschritte* type.

Abstracting Journals

In considering the abstracting journals, and limiting ourselves to the biological field, we may say that, before the war, the Germans had their *Centralblätter*; the British—at least workers in the applied field—the reviews of their Commonwealth Bureaux; and the North Americans, their *Biological Abstracts.* In such internationally minded countries as Sweden and the Netherlands it is considered *bon ton* to use all three. As none of the abstracting journals existing before the war was too complete or up to date, the question of whether it would not be better to have one single, fast, and truly international abstracting journal will be raised by many. The answer, generally speaking, will be *yes,* and emphatically so. There are, however, some problems. As is so often the case, the language problem comes first. If abstracts in various languages are mixed as Lotsy used to do in the early *Botanisches Centralblatt,* the Anglo-American reader will miss quite a little; if English only is used, the needs of all will not be served. Yet the language problem is being solved for us (as a result of the general political situation) in such a way that English is now much more dominant and useful than it ever has been.

Then too, experience has taught us that it is useful to see certain publications abstracted in different journals. Those who use some of the reviews of the Commonwealth Bureaux in addition to another abstracting journal will easily agree. We must remember, however, that the world of biology, and of many other branches of science, is small and that its resources are limited. International relations will be promoted best by our support of *Biological Abstracts,* which is now the most truly international abstracting journal, and only in the second place such special journals as may be of additional use to us. Mention should also be made of UNESCO's recent efforts to avoid the overlapping of abstracting services, particularly between the existing biological and the mushrooming new medical abstracting journals.

A third problem has been presented to us by the able and active librarians of the U. S. Department of Agriculture. Their new *Bibliography of Agriculture,* a monthly list of agricultural and biological publications, is so complete, reliable and up to date that for many purposes it will be more useful than any abstracting journal. This again raises the old problem of titles of new publications *versus* abstracts—a problem which several German abstracting journals attempted to solve by dividing their contents into two sections. It is not impossible that this method has its advantages and that abstracting journals of the future will consist of as complete lists of new literature as can be compiled, followed by a limited number of abstracts of the more important papers. Many papers can be abstracted in very few words; an explanation of the title will often do quite well. Such explanatory abstracts can be given in the list of new publications, as Lotsy did in the *Botanisches Centralblatt* lists and as the U. S. Department of Agriculture group often does in the *Bibliography of Agriculture.* It often seems that abstracting and review journals, including the annual reviews, by devoting some 5 or 10% of their space to the material which now appears in the few scientific news journals—particularly intelligence concerning international and social affairs, about which the average scientific worker is badly informed—could promote international scientific relations and professional standards greatly without, in any way, lowering their standards.

Textbooks, Handbooks, and Reference Books

Text-, hand-, and reference books also offer a number of problems of international interest. The most timely of these, and one with which we are all familiar, is the technique of reprinting by various processes books which are in some way or another not available for international distribution. This was done on a large scale during the recent war under the auspices of the U. S. Alien Property Custodian, and, as a result, many rare and out-of-print, important books and periodicals have now been made easily available to the entire world.

There is another important problem which should be discussed briefly in this connection. In science many important and interesting books have, in recent decennia, been published at a considerable loss by institutions and individuals, and many other books remain unpublished because sufficient funds for their publication cannot be raised. This is not always necessary. In somewhat normal times it is often felt—and erroneously so—that a book has been made available to the world at large by the mere fact that it has been produced in printed form. Every sound scientific memoir, unless it is of very special and local interest, can be produced without too much loss and be made widely available if: (1) one makes sure that the book is reviewed well all over the world, particularly also in journals which one does not normally see and which are even in a language one cannot read; nearly every major country of the world has journals of the type of *Nature* or *Science,* and though they may not always appear too important from our point of view, they offer excellent review media for our books; (2) a descriptive circular about the book is distributed among the principal libraries and institutions throughout the world; (3) arrangements are made so that the book will be available directly from a good number of leading foreign booksellers. The latter is particularly important under present circumstances, when it is often difficult for an individual abroad to send even the smallest payment to another country. Such matters will be expedited when UNESCO's book coupon scheme materializes.

Popular Books and Journals

Popular books and journals often exercise much more influence than one would expect. Such German journals as *Die Umschau* and *Mikrokosmos,* for example, had a surprising number of readers in southeastern Europe, just as today such journals as *The Scientific Monthly, Science Newsletter,* and many popular North American natural history journals find many regular readers in Latin America.

Directories

Since the middle of the last century international scientific address books have exercised much useful influence. Unfortunately, they cannot be prepared too soon after a major war. Today it might be best to prepare emergency directories in certain fields by reproducing by offset the latest membership lists of the leading societies of the world, with a good index, under one cover.

The number of active workers in even such a special field as the plant sciences (at least 100,000) is now so large that it will be difficult to include them all in a future directory. If one starts dividing plant scientists into various groups, e.g. plant pathologists, physiologists, taxonomists, etc., as has been suggested, one finds that the amount of overlapping is so considerable that it becomes very difficult to decide who should be included and who not.

In whatever way scientific address books are prepared in the future, there should be a clear differentiation between the general scientific interests (e.g. plant pathology) of those included and their current activities (e.g. research on cereal rusts). If those included are made to report well about their current activities, international scientific directories will play,

in the future, a much more important part in the promotion of international relations than they have in the past.

Bibliographies and Indices

Large bibliographies, encyclopedias, and indices, formerly often prepared on a national basis, obviously can be prepared much better on an international basis. Many publications issued in Germany or Great Britain before World Wars I and II can now be resumed or continued and developed only by a world-wide network of collaborators. The problem of organizing things well and issuing instructions which will be really understood and followed by those taking part in the project, in order to obtain a certain degree of uniformity and the necessary scientific accuracy, looms much larger than ever before.

The National Diet Library of Japan

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ON FEBRUARY 4, 1948, THE TWO HOUSES of the National Diet of Japan enacted legislation, by unanimous votes, establishing a National Diet Library and making provisions for a building to house its activities. Dr. Tokujiro Kanamori, who, as minister without portfolio in the Yoshida Cabinet of 1946–47, was conspicuously successful in negotiating the adoption of the new Japanese Constitution, has been appointed the first chief librarian of the new institution, which will attempt to provide a number of services not heretofore supplied by the Japanese library system.

That the development of libraries in Japan is a comparatively recent phenomenon is illustrated in Table 1, in which only libraries of 3,000 or more volumes are represented. The data for this table are taken, to the extent that they are available therein, from the special report on "Libraries in Japan (Each Containing 3,000 Volumes or Over)," issued by the Civil Information and Education Section of General MacArthur's Headquarters on March 29, 1947 (AR-279-CR-A-11).

TABLE 1

Date of establishment	No. of libraries
Before 1860	2
1860 to 1869	4
1870 to 1879	11
1880 to 1889	16
1890 to 1899	16
1900 to 1909	109
1910 to 1919	186
1920 to 1929	330
1930 to 1939	123
1940 to 1946	61
	858

Of the 49 libraries which were established prior to 1900, 30 are attached to institutions of learning; only 8 are public libraries, 7 are privately-owned establishments, and 4 are collections belonging to the national government, including the Imperial (now the National) Library in Tokyo. The enormous increase in the rate of establishment of libraries after the beginning of the century is to be attributed specifically to the enactment of a library law in 1899. At the Louisiana Purchase Exposition in 1904 the Japanese Government presented an exhibit calling attention to its rapidly growing library system (*Public Libraries*, 1904, 9, 467). Library development from 1900 to 1946 was, in fact, very general. Of the 809 institutions represented in the table, public libraries claim 391, but 246 are designated as "private" and include the research collections of industrial and other corporations as well as special collections devoted to public use by foundations and private owners. One hundred fifty-four of the total are attached to schools, colleges, and universities, and 18 are the libraries of national governmental agencies. Including collections of all sizes, the Japanese Ministry of Education has reckoned that there were in Japan no less than 3,398 library installations as of May 1, 1946.

One-sixth of all the libraries of 3,000 and more volumes were concentrated within the Tokyo area. (The past tense must be used, because a number of these libraries were destroyed during the war.) In addition to the National Library at Ueno Park, there were in this group 25 libraries belonging to the national government. The Tokyo metropolitan system included 28 libraries, of which the oldest and largest was the Hibya Library, founded in 1906, while the rest consisted for the most part of very moderate-sized collections. There were 67 school, college, and university libraries and 24 privately-owned collections. There were a number of scientific and technological libraries in each class, but few good collections. While it is true that roughly one-half of the 145 libraries in the group were of less than 20,000 vol-

umes, the fact remains that there were 18 collections of 100,000 volumes and over, and 2 collections of more than 1,000,000 books. Only 3 of the 18 collections, as may be seen in Table 2, suffered damage as a result of the war, though since the war the books of the South Manchurian Railway have in large part been taken over by the occupation forces.

TABLE 2

LIBRARIES OF 100,000 OR MORE VOLUMES IN THE TOKYO AREA

	Collections, 1946 (volumes)	War losses (volumes)
National government:		
National Library	1,037,190	.....
Imperial Cabinet Library	470,852	46,695
Imperial Palace Library	300,000	.....
Ministry of Justice	160,000	.....
South Manchurian Railway	100,000	.....
Metropolitan:		
Hibya Library	500,000	205,780
University:		
Tokyo University	1,250,000	.....
Waseda University	600,000	40,000
Keio Gijuku University	350,715	.....
Tokyo University of Literature	260,501	.....
Tokyo Industrial University	257,039	.....
Chuo University	125,641	.....
Meiji University	100,000	.....
Private:		
Oriental Library (Toyo Bunko)	502,000	.....
Ohashi Library	190,200	.....
Seikado Bunko	180,000	.....
Tamagawa Gakuen	176,671	.....
Oriental Culture Research Institute	101,130	.....

Great variation is found in the principal libraries of Tokyo with respect to the ratio of Oriental to Occidental books in the collections. Generally speaking, the special and research collections tend to include a higher proportion of Western books, unless, like the Seikado Bunko, they specialize in Chinese classics. Some examples of comparative holdings, drawn from "Libraries in Japan," are given in Table 3.

TABLE 3

Library	Ratio of Western books to total collections (%)
Seikado Bunko	0
Imperial Cabinet Library	9
Imperial Palace Library	13
National Library	16
Waseda University	33
Oriental Library	40
South Manchurian Railway	40
Mitsubishi Economic Research Institute	44
University of Tokyo	50
Tokyo Industrial University	58
Science and Technology Research Institute of the University of Tokyo	77

While the foregoing facts testify to remarkable activity in the development of libraries within a very brief period, much remained, and much still remains, to be done. According to the report of the Ministry of Education, cited in the General Headquarters Report, while 10,828 urban areas (including 210 cities) were provided with library facilities, another total of 8,056 (including 53 cities) lacked such facilities. Quite apart from the extent to which library facilities have been made available to the Japanese population, however, a number of circumstances have affected the adequacy of Japanese libraries. Principal among these is lack of trained staff. In the early days a number of Japanese librarians received their training abroad, as did I. Tanaka, who was sent to the United States in 1889 to study under Justin Winsor before becoming in 1890 librarian of the Imperial University, where he prepared in 1900 a manual of library work for use by his countrymen. With the growth of Japan's self-sufficiency and suspicion of foreign training, such instances have become less rather than more frequent in recent years. A library school was established at the Imperial Library in 1921, but until 1946 its students were accepted directly from the secondary schools, and because the training was not associated with that of any degree-giving institution, its graduates had no professional standing, could not command adequate salaries, and comparatively few of them remained in library work. As a result, directors of libraries are all too frequently, if not indeed generally, recruited from other professions and lack specific library training.

Connected with this general situation are certain other defects in the Japanese library system. The Japanese Library Association, though established in 1892 and subsidized by the Ministry of Education, seems to have been an ineffectual body so far as wrestling with the specific problems of librarianship is concerned. While a Nippon Decimal System has been elaborated for the classification of books, there are no genuinely accepted standards of cataloging and classification, and, in any case, there has been no establishment for performing central cataloging services which might have erected standards and eased the burden of duplication of effort by individual libraries. Consequently, also, there is no union catalog, and correspondingly small opportunity for an efficient interlibrary lending system. There is no central depository or distribution agency for governmental publications. Moreover, libraries generally charge a fee for their services, even though a small one. The principle of the open-access collection seems never to have gained general acceptance, and libraries are consequently accused of locking up their books and of being more interested in preserving them than in promoting their use. In the universities the prevalence of the departmental and professorial libraries has tended

greatly to weaken the central library collections.

Perhaps even more acutely than in other fields of endeavor, the written form of the Japanese language proves an obstacle to Japanese library progress. Lacking the beautifully simple device of an alphabetic order which is employed so usefully and universally in Western library practices, Japanese librarians and users of libraries have been compelled to maintain or to consult separate systems for Oriental and Occidental books and to have resort to much less convenient methods of access to the former. The University of Tokyo Library, it is true, maintains a catalog of Oriental books alphabetized on the basis of Roman transliteration; but this procedure required a wholly additional and distinct operation.

It may well be conjectured, too, that the development of libraries in Japan has been hampered by earthquakes, though it might be difficult to determine the extent to which this is true. Furthermore, an argument might be made that, by leading to the replacement of inadequate buildings and outworn collections, the cause of libraries has been advanced. But the earthquake of 1923, which destroyed 550,000 volumes out of 800,000 in the Tokyo Imperial University, resulted in the loss of twice as many books (estimated at a million and several thousand in the *Library Journal*, 1923, **28**, 856, 926; 1924, **29**, 81) as were destroyed in the bombings of 1944–45. At the very least, in the competition for new construction which followed the earthquake, the National Library has failed to secure more than one-third of the plant which was planned for it as long ago as 1902, is still compelled to make use of a frame building for a substantial portion of its activity, and has principal reading space for only 371 readers while long lines of would-be readers form outside its doors.

Of the effects of the war upon libraries, specific war damage is probably not the most serious, and the end of the war found the Japanese libraries in a bleak situation. Many collections had been evacuated, and some have still not been returned. Neglect of buildings, inability to purchase foreign books, and depletion of staffs have taken their toll. Inflation has reduced library budgets in many cases to practically nothing, and the same cause is operating cruelly on the individual members of this low-paid profession. Like other public buildings, libraries in Tokyo are unheated in winter and severely limited in the amount and duration of use of electric light.

Specific war damage to buildings or collections was suffered by 138 of the libraries of 3,000 or more volumes throughout the country, though a library is listed as damaged equally whether its loss consisted of 14 or of many hundreds of thousands of volumes. Public libraries constituted 65% of those which received injury. The heaviest casualties were in the Tokyo metropolitan area, where 46 of the libraries in the class having 3,000 volumes or more were damaged. The public library system suffered most heavily, with total losses of more than 414,088 volumes by 26 libraries, of which 8 were completely destroyed. Of the 24 private libraries only 4 were damaged, with losses of 19,400 volumes, and none of the large collections suffered loss. Five institutions in the school, college, and university group suffered losses, but with the exception of Waseda University's 40,000 volumes, these were trifling, amounting to approximately 5,000 volumes. Of the governmental collections, the Imperial Cabinet Library lost 46,695 volumes; the Ministry of Agriculture and Fisheries, its entire collection, which numbered 5,200 volumes in 1937; the Ministry of Foreign Affairs, its central collection of 40,000 volumes; the Finance Ministry, its catalog and indices; the Transportation Ministry, 69,000 volumes, although 10,000 were in evacuation; and the Bureau of Patents and Standards, 15,528. It thus appears that, in spite of the enormous area (over 85 square miles) which was devastated in the air raids over Tokyo, the total destruction of books, which amounted to approximately 655,000 volumes, only slightly exceeded the losses wreaked time and time again on individual libraries in Germany, e.g. the University of Hamburg, 600,000; the Landesbibliothek, Stuttgart, 580,000; the Staatsbibliothek, Munich, 500,000 (*Zentralblatt für Bibliothekswesen*, 1947, **61**, 24).

The Allied Occupation has continuously recognized that the reconstitution and strengthening of the libraries of Japan is a matter of no small importance in the whole program of rehabilitation and democratization. Reform of the educational system, the instruction of the electorate, scientific and technological advancement, the strengthening of local institutions—all these objectives as well as others depend in large part upon the availability of information which is in great measure the responsibility of libraries to provide. Consequently, a library officer has been assigned to the Civil Information and Education Section of General MacArthur's Headquarters, and the Section has been particular, also, in compiling data upon conditions in Japanese libraries. A number of projects are in active status and others are in contemplation. The library school at the National Library has been revived and reformed on a graduate level of instruction; the Japanese Library Association has been encouraged to hold frequent meetings and to engage in basic studies such as a revision of the Nippon Decimal Classification, the preparation of a glossary (sorely needed) of Japanese bibliographical terms, and programs of microfilming. A revision of the library laws is in preparation, looking to the

decentralization of the local institutions which have hitherto been dominated by the central government. Most important of all for immediate purposes is the system of information libraries which is operated by the Section in 4 cities throughout Japan, replacing in large measure the bombed-out public libraries and bringing to Japanese readers a new-found wealth of current books, including a large proportion of U. S. publications. While these collections are general in content, they are well stocked in scientific and technological literature. In the library in Tokyo, readers average 700 per day, and the use of scientific and technical material greatly exceeds that of any other class, constituting 38% of the total in the case of books and 49.6% in the case of periodicals (*Library Journal,* 1948, **73**, 162).

Until 1946 the libraries of the two Houses of the National Diet were content to remain quiet reading rooms where the Members could consult the daily papers and perhaps refer to the bound volumes of the records of debate. Both libraries are coeval with the Diet itself, which convened for the first time in 1890. Several fires have punctuated their existence; the second of these was in 1925, when the wooden Diet Building in Hibya Ward burned with the loss of large portions of the collections. Since 1936 these have been situated in opposite wings of the new fireproof Diet Building in Kojimachi Ward, and by 1947 their collections had grown to 36,000 volumes in the library of the House of Councillors and 60,000 in that of the House of Representatives, not counting large collections of periodical issues, pamphlets, etc. Of the books, 90% were in Chinese or Japanese. This means that not even the series of parliamentary proceedings (Hansards) of the principal Western countries were available to the Japanese legislators.

The reason for this apathy was not far to seek. The Japanese Diet was a politically impotent body: at its best, it was but a debating society; at its worst, it was but a rubber stamp wherewith the government put a facsimile of parliamentary and popular approval upon its acts. Being devoid of responsibility, it had no need of precise information; it had no real need of a library. (Cf. *The Japanese Diet: old and new,* by Justin Williams, chief, Legislative Division, Government Section, GHQ, SCAP; *ms.*)

By the new Constitution of Japan promulgated on November 3, 1946, and effective 6 months thereafter, this situation was entirely changed. Indeed, it had changed before the promulgation of the Constitution, for the principal job of the Diet of 1946 was to debate, amend, and ratify the draft of this supreme law of the land under which the country is to live. This was the most difficult and responsible task ever assigned to a popularly elected Japanese body, and the repercussions were felt—even in the libraries. When the supreme law was finally written, the Diet found that its new responsibility was to be a continuing one, and that henceforth it was to be "the highest organ of power in the State." No longer could it escape responsibility or remain uninformed.

A movement began to take shape looking toward the reconstitution of the Diet libraries into organs of real effectiveness as agencies of information. The forces behind this movement were from several directions. One, of course, was from within the Diet itself, demanding informational assistance in legislative problems which should be of an excellence at least equal, if not superior, to the informational assistance available to the executive branches of the government. Encouragement to this demand was given by the Government Section of the military government, which was anxious to see the Diet develop as rapidly as possible into an intelligent, informed, and responsible body. Additional support of the movement was contributed by various research agencies in the hope that a strong library erected under the aegis of the national legislature might, as in the United States, contribute greatly to the strengthening of the general library and bibliographic resources of Japan.

The first result of the movement was the adoption of the proposal that there should be a single Diet library instead of two House libraries. This was effected in the Diet Law which was enacted on March 19, 1947, to regulate the legislature's own procedures. The constitution of the Diet Library itself was spelled out in greater detail in a law enacted on March 28, 1947. The Committees on Library Management of the two Houses immediately set to work to put the plan into effect. Inquiries and plans were carried on through 1947 in conjunction with other interested groups and bodies. In the course of these studies it became more and more apparent that, to be fully effective, the Diet Library would need access to those national bibliographic services which are characteristic of modern library systems, and the idea gradually took form that it should attempt to provide at least some of these services itself. The problem became, in consequence, one of establishing not merely a Diet Library, but a National Diet Library. In these circumstances the presiding officers of the two Houses, together with the chairmen of the Library Committees, requested the Supreme Commander for the Allied Powers to invite some American experts to assist in the planning of the Library. The consultants selected consisted of Charles H. Brown, for many years the librarian of one of the principal scientific libraries in the United States (that of the State College at Ames, Iowa) and past president of the American Library Association, and myself. Dr.

Brown and I arrived in Tokyo on December 14, 1947, and (with three weeks of time-out spent in China) departed on February 12, 1948, following the enactment of the two laws which incorporated our suggestions for the organization and work of the National Diet Library. That the matter could have been brought to such a stage in so short a time, despite the great number of vexing questions which had to be settled—questions regarding function, organization, appointments, qualifications, tenure; relations between the legislative, executive, and judicial branches of the government and between the national and local governments; problems of acquisition, building constructions, etc.—was due to the energy and enthusiasm of the responsible Diet members who gave up not only their vacations but almost all their time to the study, and to the splendid cooperation between officers of the Japanese and of the military governments.

The National Diet Library Law of February 4, 1948, presumes that the first service of the Library will be in assisting the members and committees of the Diet in the discharge of their duties. It provides, however, that the Library shall also be a principal library for all branches of the government, with responsibilities for assuring that adequate library services are provided for all agencies; and that it shall be equipped with authority and with advisory assistance to effect coordination necessary to assure economy and efficient use of resources. It also stipulates that the Library shall provide certain national library services which are now wanting.

It is proposed that the collections of the library shall be collections for immediate use, not a collection of bibliographical treasures. These may follow, as gifts; but the book funds of the Library are to be used, within the foreseeable future at least, for acquisitions of greatest utility. Japan is poor; yet that country needs great quantities of foreign books. No one library can afford to secure them all. The National Diet Library must take the lead in seeing that the needs of Japanese research are met through the cooperative effort of many libraries.

In the service of the Diet the Library will maintain a Legislative Reference Service. This is planned on the model of American institutions and, specifically, on that of the Library of Congress. The job of this Service is to collect and assemble facts which bear on legislative problems. It is obvious that a very extensive library is required for its use. As one of its specific duties, the Library is required to prepare, in publishable form, an index to the laws of Japan.

To the other government agencies, of both the executive and judicial branches, the Library is required to provide a service subordinate only to that which it offers the Diet. Each agency is required to have its own working library, but books are to be interchangeable between all collections through uniform systems of cataloging and classification and through the maintenance of a union catalog. The objective is to make any book owned by the government available to any officer of the government and to avoid unnecessary duplication and overlapping. An advisory council, consisting of the chairmen of the Library Committees, a justice of the Supreme Court, and a cabinet minister, makes recommendations to the Diet regarding governmental library service generally.

It is expected that the influence of the National Diet Library will extend far beyond Tokyo. The Library is authorized to provide central cataloging services to other libraries, to organize a national union catalog, to engage in and promote interlibrary lending, to provide microfilming and other photoduplication services, to assure the compilation of a national bibliography of Japanese publications and of the bibliography of governmental publications, and to promote, by advice and otherwise, the establishment of essential library services throughout Japan. It is anticipated that, by using a Romanization of Japanese in its own operations, the Library may assist in securing the advantages to be obtained from the general acceptance and use of Romaji.

A companion statute authorizes a building commission to start immediately to plan the structure which will house these activities.

All this constitutes a formidable program, but the need and the enthusiasm combine to assure its execution. Two further facts of significance in this connection may be mentioned. The first of these relates to the position of the Librarian. He is to be of ministerial rank. This provision, which exceeded the original tentative recommendation of the American advisers, was insisted upon by the Japanese; the Diet wants nothing less than the strongest hand to develop these national library services. The second relates to the position of the National Library at Ueno Park. This collection, though supported by the Ministry of Education, is now largely serving as the principal municipal library of Tokyo and will continue to be needed in this capacity. Such a development, requiring reorientation regarding the municipal services of the Tokyo area, is provided for in the law.

In accepting the report of the American advisers on the National Diet Library, General MacArthur took the initiative in suggesting that follow-up advice be secured in order to assure the success of the program. A successor to the original advisers is consequently now being designated. Certainly, few individual projects hold greater promise for aiding good government and for assisting research and the free flow of information.

NEWS and Notes

John Otis Brew has just been named director of America's oldest anthropological museum, the Peabody Museum of Archaeology and Ethnology at Harvard University. Dr. Brew succeeds **Donald Scott**, who has been director since 1932. The new director, a member of the Museum staff since 1930, has participated in archaeological expeditions throughout the United States and in Ireland.

Charles K. Weichert, a member of the University of Cincinnati faculty since 1928, has been appointed head of the University's Department of Zoology, effective September 1, to succeed **Harry L. Wieman**, who will become emeritus professor upon his retirement this summer.

Russell C. Erb has been appointed professor of chemistry and head of the Department at the Pennsylvania Military College, Chester.

J. Howard Dellinger, chief of the Central Radio Propagation Laboratory, National Bureau of Standards, retired on April 30 after more than 40 years of government service. Initiating radio research at the Bureau in 1911, he was made chief of the Radio Section upon its establishment in 1919. The term, Dellinger Effect, was derived from his discovery of the simultaneous occurrence of solar eruptions and radio fadeouts.

Carl H. Milam, executive secretary of the American Library Association, has been appointed director of libraries for the United Nations. Dr. Milam took up his new duties on May 1.

William Frankena, professor of philosophy and chairman of the Department of Philosophy, University of Michigan, will be on sabbatical leave during 1948–49. Dr. Frankena, working under a Guggenheim Fellowship, plans to write a history of ethical thought and moral philosophy in Great Britain and the United States.

John F. Fulton, chairman of Yale University's Department of Physiology, will deliver the William Withering Memorial Lectures at the University of Birmingham, England, next month. His four lectures, June 7–10, will be on the physiological basis of the frontal lobotomy. On July 3 Dr. Fulton will receive an honorary D.Sc. degree from the University of Birmingham.

Charles F. Park, Jr., professor of geology at Stanford University, will fly to Brazil in June for the purpose of mapping iron ore deposits and the general geological structure at Itabiri, north of Rio de Janeiro. Dr. Park is going to the Brazilian highland country for the U. S. Geological Survey. The three-month project, financed by the State Department, is being undertaken in cooperation with the Brazilian government.

W. Harley English, formerly associate professor, Oregon State College, has been appointed assistant professor and assistant plant pathologist, and **Raymond G. Grogan**, formerly a graduate assistant at the University of Wisconsin, instructor and junior plant pathologist in the Division of Plant Pathology, University of California, Davis.

J. Christian Bay, librarian emeritus of the John Crerar Library, Chicago, will deliver the second William Allen Pusey Memorial Lecture of the Institute of Medicine of Chicago on Friday evening, May 28, at the Palmer House. His subject will be "The Search for the Vital Principle."

Grants and Awards

Natal University College, Union of South Africa, has announced the receipt of a $15,000 grant from the Carnegie Corporation for use in the college library.

The Third Intermediate Sugar Research Foundation Award was presented to Leslie F. Wiggins, of the University of Birmingham, England, at a dinner held on the evening of April 26 at the Hotel Biltmore, New York City. By winning this year's $5,000 prize, Dr. Wiggins becomes eligible for the Grand Award of $25,000 to be given by the National Science Fund in 1950. The first Sugar Research Foundation prize was shared by W. Z. Hassid, H. A. Barker, and M. Doudoroff for the first synthesis of sugar which has made possible "tracer" studies of the metabolism of sugar in the human body. The second annual award went to Carl F. Cori, recent Nobel Prize winner, for his contributions to the knowledge of the manner in which the body uses starches and sugars. Vincent du Vigneaud, professor of biochemistry at Cornell University Medical College, speaking in behalf of the National Science Fund at the presentation dinner, termed Dr. Wiggins' research as "a milestone in the advance toward better use of cheap and abundant plant products to serve the myriad needs of civilization." Robert C. Hockett, scientific director of the Foundation, laid emphasis on the international character of the plan for studies of sugar as a food and an industrial material. Certain phases of the studies have been undertaken in England through the Colonial Products Development Council and the recently created Imperial College of Tropical Agriculture, in Kingston, Jamaica, of which Dr. Wiggins has been appointed research director.

By utilizing sugar in various ways Dr. Wiggins has shown the possibilities of its becoming the source of many important organic chemical compounds. He has worked out an efficient conversion method for the production of levulinic acid, which has enabled the making of such varied products as sulfa drugs, nylon ingredients, and a synthetic coconut flavor. It has also been shown at Birmingham that an excellent antifreeze may be made from the calcium salt of levulinic acid.

At the annual meeting of the American Association of Petroleum Geologists held recently in Denver, Arville I. Levorsen, head of the School of Mineral Sciences, Stanford University, and past president of the Geological Society of America, received the Sidney Powers Memorial Award "in recognition of distinguished and outstanding contribution to, and achievements in, petroleum geology." The Association's President's Award of $100 went to L. L. Sloss, of Northwestern University, and W. M. Laird, of the North Dakota Geological Sur-

vey, for their joint paper, "Devonian System in Central and Northwestern Montana," selected as the most significant original contribution to petroleum geology published during 1947 in the Association's monthly bulletin by authors under 35 years of age.

The 1947–48 Joseph W. Lippincott Award will be made at the Atlantic City Conference of the American Library Association, June 13–19. The award, which was temporarily discontinued in 1941, will be given for distinguished library service during the year which constituted a contribution of enduring value to the philosophy or methods of librarianship. It consists of a $500 gift and certificate. John MacKenzie Cory, University of California, Berkeley, is chairman of the Committee on Awards.

D. W. Woolley, associate member of the Rockefeller Institute for Medical Research, is the recipient of the first Research Award of the American Pharmaceutical Manufacturers Association. The award was made at the Association's recent Havana meeting. Dr. Woolley's special interests are in the field of nutrition as related to biochemistry and bacteriology; isolation, characterization, and investigation of mode of action of vitamins and bacterial growth factors; and analogues, or compounds structurally similar to vitamins but antagonistic to them.

Fellowships

The Conway MacMillan Memorial Research Fellowship in Botany is available at the University of Minnesota for the year 1948–49. This Fellowship, established in 1946 by Charles J. Brand, of Washington, D. C., in honor of the late Prof. MacMillan, is awarded annually to doctoral students of promise and ability in the field of botany in its broadest sense. Applicants should have a Master's degree from the University of Minnesota or an institution of learning of similar standing, or equivalent experience in their fields of concentration. According to the terms of the gift, special mention is made of those from the University of Chile and the Catholic University of Chile. The recipient receives a stipend of $1,200 for the academic year and is exempted from tuition in the Graduate School. Applications should be made by June 10. All inquiries should be addressed to: A. O. Dahl, Chairman of the Conway MacMillan Fellowship Committee, Department of Botany, University of Minnesota, Minneapolis 14, Minnesota.

A Standard Oil Company of California Graduate Fellowship in Chemistry has been established at the University of Southern California for the academic year 1948–49. No specific restrictions are placed upon the nature of the research to be pursued. The stipend is $1,250, plus tuition if the recipient is not eligible for benefits under the Servicemen's Readjustment Act. On the basis of merit, the award for 1948–49 has been made to Hershel L. Herzog, candidate for the Ph.D. degree in organic chemistry.

Meetings

The Special Libraries Association will convene June 6–11 at the Hotel Statler, Washington, D. C. According to Jane Brewer, convention chairman, preliminary plans have been made for the nearly 1,000 librarians expected to attend the meeting. A guided tour to places of interest near Washington, D. C., has been arranged for June 6, and the following day will begin a two-day Federal Library Institute, under the direction of Luther H. Evans, Librarian of Congress. The Institute will offer an opportunity for study of special library methods in libraries of the Federal departments and bureaus. The following speakers will participate in the Institute: Fred W. Cromwell, Superintendent of Documents; Col. Joseph McNinch, director of the Army Medical Library; the Hon. Charles F. Brannan, Assistant Secretary of Agriculture; Alexander Wetmore, secretary of the Smithsonian Institution; and J. C. Capt, director of the Bureau of the Census.

Meetings of subject-interest groups are scheduled for June 10. These will be addressed by experts in fields of knowledge used in advertising, business, finance, insurance, science-technology, social sciences, transportation, education, legislative research, and fine arts.

Summer field meetings will be held in New Jersey, June 15–19, by the Northeastern Section of the Botanical Society of America in cooperation with the Ecological Society of America, the Torrey Botanical Club, the American Society of Plant Taxonomists, and the Sullivant Moss Society. The objectives of the meetings will be (1) a survey of the vegetation of New Jersey and its ecological basis and (2) the ecology of New Jersey's oyster beds. June 15 will be spent in northern New Jersey. That evening there will be two talks at New Brunswick: "The Geology of New Jersey," by Peter Wolfe, of Rutgers University, and "New Jersey Pollen Sequences as Seen From New England," by E. S. Deevey, of Yale University. June 16 will be spent at New Brunswick. Three talks are scheduled for the morning: "Climate of New Jersey," by C. W. Thornthwaite, Seabrook Farms; "Profile Characteristics of New Jersey Soils," by J. S. Joffe, and "Origin of the Pine Barren 'Plains,'" by H. J. Lutz, Yale University. In the afternoon there will be a trip to a piedmont oak-hickory forest, and in the evening W. H. Camp, of the New York Botanical Garden, will lecture on New Jersey disjuncts. On June 17 there will be visits to coastal bogs and off-shore bars, while June 18 will be spent in the pine barrens. Two alternative trips are planned for June 19: a visit to the Delaware oyster beds or a visit to the Seabrook Farms.

Persons planning to attend should inform the local committee by May 25. Correspondence should be addressed to: Dr. M. A. Johnson, Rutgers University, New Brunswick, New Jersey.

A Symposium on Technical Journalism was held at the April meeting of the American Chemical Society in Chicago in observance of the 40th anniversary of *Industrial and Engineering Chemistry*. Sponsored by the Society's Divisions of Industrial and Engineering Chemistry and Chemical Education, the symposium featured 12 speakers. One of these, W. Bradford Wiley, of John Wiley & Sons, spoke on "Scientific and Engineering Texts—Some Contemporary Problems

of Authors and Publishers,'' reporting that, with some manufacturing costs up from 80 to 100% since 1945, a technical publisher must now sell 5,000 copies of a modestly priced book to recover production costs and expect a small profit. Twenty-five years ago the sale of 1,500 copies would have achieved the same objective. He attributed the greatest expense of textbook production to the method of type-setting involved, the use of unusual mathematical symbols and tabular and formula matter requiring hand composition. To date, advances in printing technology have failed to bring large savings, but the hope was expressed that it might be possible to modify some of the new printing methods, such as those developed during the Chicago newspaper strike, to apply to technical publishing. This latter method is essentially a refinement of the photo-litho process. Although increased college enrollments, greater industrial demand, and an active foreign market have made it possible for publishers to avoid price increases proportional to increased production costs, Mr. Wiley stated that many worth-while and needed books are not being published simply because their market potential is too low.

The activities of the Library Committee of the Notgemeinschaft will be reported in an article now in preparation by F. Schmidt-Ott, 88-year-old founder of the old Notgemeinschaft der deutschen Wissenschaft (Emergency Society for German Sciences, a university association for the support of sciences in the general poverty after 1918). It is expected that this essay will be published in the *Zentralblatt für Bibliothekswesen*. George Leyh, librarian emeritus of the University of Tübingen, writes that the difficulties involved in organizing a new Notgemeinschaft are far greater than after World War I, largely because of the destruction of the German State as a political entity. He feels that the first task for the reconstruction of German research libraries is to fill in gaps in periodicals and serials from 1939 until now and, the second, to restore book losses with a view to the history and special strong points in each library's collections. Those interested in sending printed matter to Germany, as either gifts or exchanges, will be interested to know that the International Exchange Service of the Smithsonian Institution now accepts such matter for transmittal in all four zones. The Service has available a folder describing the exact procedure which should be followed.

A Colonial Microbiological Research Institute, erected by the Colonial Products Research Council in Port of Spain, Trinidad, will be opened officially on Monday, July 5, by the Rt. Hon. Lord Hankey, chairman of the Council. The Council's decision to establish the Institute followed the recommendation of Sir Robert Robinson and Prof. J. L. Simonsen, who visited the Caribbean in 1944. Invitations to attend the opening, which will be followed by two days of scientific meetings, have been extended to Canada, the United States, the Caribbean Commission, and a number of South American Republics. A. C. Thaysen, formerly of the Chemical Research Laboratory, Teddington, will direct the Institute's activities.

The U. S. Atomic Energy Commission and the Office of Naval Research have agreed upon a program of joint support of fundamental scientific research in physical and medical fields in which the two agencies have a common interest.

AEC will make available up to $3,000,000 for physical research and $1,000,000 for medical and biological research for a one-year joint program. This will make possible the extension of the present ONR projects in fields related to the national atomic energy program and the initiation of some new projects.

Nearly 750 ONR research projects, started at 130 institutions during the two years of operation of ONR, are being studied with a view to their possible selection for extension or intensification through joint sponsorship. Twenty-nine medical and biological research contracts, including cancer studies, have been selected for support entirely by AEC funds. About 30 projects in nuclear physics have been tentatively approved by AEC for joint support. All contracts selected under the joint program for AEC partial or entire financing will be administered by ONR. The extension of an existing project in this cooperative program will, of course, be subject to the approval of the present contractor.

The work involved is unclassified, and is done in nongovernmental laboratories, hospitals, universities, and other research institutions. The cooperative program will insure coordination of research in fields in which there is a serious shortage of qualified scientific personnel.

The physical science projects cover a wide range of investigations of a fundamental nature in nuclear and general physics, chemistry, metallurgy and ceramics, mathematics, and geophysics.

Funds for the support of the AEC-ONR research on cancer are included in the Commission's recently announced cancer research program, undertaken with Congressional authorization.

Make Plans for—

American Society of Plant Physiologists, meeting of New England Section, May 21–22, University of Massachusetts, Amherst.

American Neurological Association, June 14–16, Claridge Hotel, Atlantic City, New Jersey.

American Society for Engineering Education, June 14–18, University of Texas, Austin.

Mycological Society of America, annual foray, June 15–17, Biological Station, University of Michigan, Cheboygan.

Conference on Hemoglobin, June 15–18, Cambridge, England.

American College of Radiology, June 18–20, Continental Hotel, Chicago, Illinois.

★ ★

AAAS
Centennial Celebration
Washington, D. C.
September 13–17, 1948

★ ★

Comments and Communications

Phosphate Coating of Aluminum and Polymorphism of Chromium Phosphate

Articles of aluminum are usually treated by a process called bonderization or Parkerization to form a thin protective layer on the surface which gives an electrical and heat insulating coating and constitutes a good base for paint or other finishes. A recently developed method for coating aluminum is to treat the surface of the metal with a chromic acid and phosphate solution (R. C. Gibson and W. C. Russell. *Ind. eng. Chem.*, 1946, 38, 1222; C. H. Horace. Brit. Patent 398,180; J. S. Thompson. U. S. Patent 2,234,206). One sample of such a coating, light green in color, shows the following composition upon chemical analysis: coating weight, 160 mg/sq ft of surface area; Cr, 14.5%; Al, 9.8%; PO_4, 32.7%; F, 7.5%.

TABLE 1

Form	Description	Hydrate	X-ray powder method results
(I)	Light violet, freshly precipitated in cold	6	Characteristic pattern
(II)	Violet crystal transformed from (I)	6	Characteristic pattern
(III)	Green crystal transformed from (II) by heating in water	4	Diffraction pattern same as (II)
(IV)	Green crystal transformed from (II) by heating in glacial acetic acid	4	Diffraction pattern same as (II)
(V)	Fresh precipitate formed in hot solution	Not const.	No dif. pattern
(VI)	Green crystal by heating (II), (III), and (IV) at 120°	2	No dif. pattern
(VII)	Black residue obtained by igniting the above forms	0	No dif. pattern

X-ray diffraction analysis with chromium Kα radiation has been used to identify compounds present in this coating. Most of the lines correspond with those for pure aluminum phosphate prepared by mixing equivalent amounts of aluminum chloride and phosphoric acid and heating the mixture over a small flame of a Bunsen burner until no more fumes of hydrogen chloride were detectable. This pattern is entirely different from the one listed for aluminum phosphate in the ASTM Card Index. A whole series of aluminum phosphates representing polymorphism, various hydrates, and phosphoric acid forms has been found. Additional lines in the above pattern correspond to aluminum oxide and aluminum fluoride, but the chromium phosphate producing the green color is evidently amorphous. In an effort to identify this, an intensive investigation of chromium phosphates has been made, with the results shown in Table 1.

The most interesting facts are the dimorphism of the hexahydrate; identity in crystalline structure of the tetrahydrate with the hexahydrate, indicating that 2 of the 6 water molecules in the violet crystal must be zeolitic; and the amorphous nature of the compounds below the tetrahydrate. This behavior together with changes on heating indicate the presence of green chromium phosphate dihydrate on the protective coating in aluminum.

G. L. Clark and A. P. Tai

University of Illinois

National Science Foundation—A Peril to American Universities

Alluring as it may be, the prospect of easy and abundant Federal money for the promotion of science in universities through research grants and through contracts for research to be done for the Government seems to me to hold many perils to the freedom of the universities and to scientific education.

The first peril is that the National Science Foundation itself will be controlled by politicians rather than by scientists and that therefore the management may not always be in the hands of men whose first interest is the welfare of science, education, or educational institutions. According to the bill as now proposed, the 24 members of the Foundation, as well as its director, would be appointed by the President. Politics would inevitably play a part in such appointments. Scientists might offer advice and be consulted, but there seems to be no assurance that their advice would be heeded.

A second peril is that the director of the Foundation, because of his power to grant or to withhold research funds, would come to exercise a very real control of university policies and scientific activities. It would be naive to suppose that the agency supplying the funds would long continue to appropriate large sums over which it did not have definite control, both as to expenditure and as to the research projects to be paid for by those funds.

The allotment of research funds to universities would cause competition among them, and the funds would naturally go to the larger institutions best equipped to make good use of them. These would become even larger, and research and educational opportunities would be still further concentrated, to the detriment of the smaller institutions.

In the competition for grants, the general policies of the universities would necessarily be subject to strong pressure toward control by the Federal agency making the grants, for the university administration which is compliant and politically adept might reasonably expect to have its grants continued or increased, while the administration which is recalcitrant in any way might expect to be slighted.

Research grants for anything other than very temporary projects would create vested interests in space and personnel which would exert still more powerful

pressure toward compliance to the end that the grants might be continued.

A peril of a different kind comes from the tacit assumption that graduate students might do much of the routine work on research projects supported by the Government. I submit that scientific research projects set by outsiders, either by the Federal Government or by industry, have no proper place in a university. Routine work is not the function of a university or of its graduate students, but a contract for research must necessarily involve large amounts of purely routine work and will tend to make the university scientific staff merely the supervisors of the execution of tasks set by others than themselves, thus consuming their energies without developing their own initiative and ingenuity.

Another danger is that some of the work which the Government might wish to allot to the universities may be of a secret nature. Secret research is contrary to the whole idea of the free pursuit of and sharing of knowledge that university research is supposed to promote. If a branch of the Government desires that research be done, it should set up its own organization and hire its own men. The research jobs would be done, the universities would remain free, and their students would not be subjected to the vicious influence of secrecy in the search for knowledge.

As to the argument that the universities are in financial straits and that, therefore, government help is necessary, it would seem that scientists interested in the promotion of research, but at the same time desirous that science and the universities should remain free, would be better engaged in seeking an amendment to the income tax laws such as that proposed by King (*Science*, June 6, 1947, pp. 593–594) than in promoting the establishment of a National Science Foundation.

JOHN L. RICH

University of Cincinnati

A Promising Type of Male Sterility for Use in Hybrid Tomato Seed Production

While searching for male-sterile tomato plants in 1945, the writer found an interesting type of "sterility" in the variety John Baer. This mutant can be selfed by hand-pollination, but it does not self in the field, as is normally the case. It therefore can be maintained easily as a pure line through hand-pollination and can be used as a female parent in hybrid seed production without the need for emasculation. About 75% of the labor involved in hybridizing is eliminated. Natural selfing is prevented because the anthers fail to dehisce. The character appears to behave as a simple recessive. When incorporated into other desirable parental lines, it will materially reduce the cost of hybrid seed production.

Work on the "quantity collection" of pollen by means of electric-battery vibrators has been done by a large seed company, and experiments with inert diluents have been conducted intermittently during the last four years.

Thus, improvements in pollen collection and application, combined with the development of suitable "male steriles," give promise of greatly expanding the use of hybrid tomatoes.

W. E. ROEVER

West Tennessee Experiment Station, Jackson

A Comparative Study of Zygote Germination in the Saprolegniaceae

In spite of the fact that the members of the Saprolegniaceae have been studied for over a century, the germination of the resting bodies has been reported in only a few species of the family. In order to complete the life histories of these forms, 26 species belonging to 10 genera were collected and identified. Without exception, the zygotes of all species were successfully germinated when the mycelium of each form, after a rest period, was placed in fresh distilled water which had been treated with activated charcoal, filtered, and autoclaved (A. W. Ziegler, *J. Elisha Mitchell Sci. Soc.*, 1948, **64**, No. 1, in press).

The germinated zygotes fall into four types:

(A) Those in which a long or short germ tube is formed with an apical sporangium. The forms in this group included a species of *Aplanes*, and most species of the genera *Saprolegnia* and *Achlya*.

(B) Those in which the germ tube produces a sparsely branched mycelium with a sporangium at the apex of the main hypha or a branch. This type includes several species of *Isoachlya*, *Achlya americana*, and *Aphanomyces laevis*.

(C) Those in which the primary germ tube forms a branched mycelium. This group includes two species of *Isoachlya*, *Achlya glomerata*, *Aphanomyces laevis*, and *Brevilegnia linearis*.

(D) Those in which the primary germ tube forms a long, unbranched hypha. Forms in this classification include *Aphanomyces laevis* and species of *Geolegnia* and *Brevilegnia*.

The food material contained within the zygotes of the Saprolegniaceae is in the form of numerous small droplets, or one large drop of fatty reserve. Tests involving the use of Sudan III, Sudan IV, osmic acid, Nile blue sulfate, saponification, polarization, and solubilities seem to indicate that the reserve food material is true fat and that no fat-like substances are present.

Experiments involving the effects of pH on germination have demonstrated that low and high pH's tend to inhibit germination, while a pH of 6.9 allows the zygotes to germinate normally. An experiment, repeated several times, on the effects of light on germination has demonstrated that, at least for the species used in the experiment, light is necessary for germination.

A study of the literature of germinating resting bodies of other aquatic oömycetes reveals that they fall into several distinct patterns. However, these germination patterns have thrown no new light on the phylogeny of the Saprolegniaceae.

A. W. ZIEGLER

University of North Carolina

Book Reviews

Visual Aids in Geology

John Wiley & Sons are preparing a set of approximately 250 Kodachrome slides to illustrate the revised edition of the *Textbook of geology*, Part I: *Physical geology*, by the Yale authors, Chester R. Longwell, Adolph Knopf, and Richard Foster Flint. The new edition is due August 15, but it is expected that the visual material may be ready even earlier.

Most of the photographs were taken by O. E. Childs, assistant professor of geology at Colgate University, who has already prepared a set of color illustrations on general geology, as well as on historical geology, for Educators Visual Aid Service at Ann Arbor, Michigan. To secure photographs that will adequately cover so vast a subject, Childs traveled from Maritime Canada to California and from Montana to Georgia. Not content with ground shots alone, he took to the air in several parts of the country to provide broader vistas of landforms and shorelines which cannot ordinarily be encompassed from a single vantage point on the ground. Supplementing Childs' collection of photographs are pictures taken by the authors and by a few other geologists who have had exceptional opportunities to photograph special features like Parícutin.

At this date the selection of views is neither final nor complete, but gaps are being rapidly filled in. Some subjects in geology are notoriously difficult to illustrate, and in the preliminary set of photographs the authors and publisher have not yet mastered the problem of balance, which baffles every teacher and textbook writer in the field. Only a few diagrams will be included, but the text itself is the proper medium for diagrammatic material, and color slides may appropriately exploit the field in which the text is helpless, namely, in giving the most realistic impression possible of what landforms, structures, geologic agents in action, rocks, and minerals actually look like in nature.

HOWARD A. MEYERHOFF

Smith College

Visual Aids in Biology

General biology. (3rd ed.) J. W. Mavor. New York: Macmillan, 1947. Pp. x + 986. (Illustrated.) $5.50.

Laboratory exercises in general biology. (3rd ed.) J. W. Mavor. New York: Macmillan, 1947. Pp. xiv + 333. $3.25.

Slidefilm series to accompany general biology. New York: Macmillan. $15.00.

This college text has proven its usefulness during the life of the previous two editions. The third edition has been enlarged to the point where it is hoped the author will not expand further. There has been a growing tendency in texts at nearly any educational level to approach the content of an encyclopedia. These are excellent for the advanced student but of questionable value to the initiate. Mavor's text has an excellent balance between the quantity and choice of subject material and the overall amount of time that any one college subject can be expected to demand of its students.

The volume is divided into 6 parts and contains, in addition, an appendix of classification. Part 1 deals with the nature of life, beginning with the much-heralded scientific method and devoting most of its 7 chapters to protoplasm, cells, and cellular physiology. Part 2 is devoted to plant life, which it covers in 10 chapters. Part 3 introduces the invertebrates in 8 chapters, and it is to be noted that Dr. Mavor places emphasis upon a few of the phyla—notably the protozoa, the coelenterates, the flatworms, the roundworms, the segmented worms, and the arthropods. All others, including the molluscs, are briefly treated in a single chapter. In Part 4 (10 chapters) we find a discussion of the anatomy and physiology of frog and man. Part 5, on development and heredity, appears in 3 chapters, and Part 6, on the organic world and its evolution, ends the text portion with 6 chapters ranging through ecology, the history of life on the earth, the theory of evolution, the evidences for, and the mechanisms of, organic evolution, and early man.

Dr. Mavor has followed sound teaching policy in the construction of his book. From the student's standpoint, his clarity of style, the black-faced type for important words, the careful organization, the summary topical outline, and the questions at the end of each chapter make it highly desirable both as a source of information and a book easily studied. The diagrams and figures are excellent, and the text has been well illustrated with many photographs. The content is essentially orthodox. Controversial issues which often worry students are left to the instructor, as well they might be in an elementary text.

Published with the text and correlated with it is Dr. Mavor's *Laboratory exercises in general biology*. It is a good laboratory manual as manuals go, but I rather suspect that most of us prefer to run our laboratories according to our own notions and are therefore not as dependent upon laboratory outlines as we are upon a good solid textbook.

Last but not least, Dr. Mavor and the Macmillan Company have pioneered in furnishing 35-mm film strips as visual teaching aids. Teachers will be glad to know that publishers are aware of the need of well-correlated visual material to accompany textbooks. This present approach appears to be experimental, for only three "slidefilms" are available, one on the alternation of generation of plants, one on plant physiology, and one on life through the ages, which is mostly animal in its treatment. These vary in length but present, with titles, about 50 frames.

The two botanical strips, which are well done, depend largely upon drawings and diagrams to present the facts and the concepts. Some of the figures appear in the text, some have been redrawn to change the presentation, and some do not appear in the book at all. The third, on life through the ages, is largely material that does not appear in the text. Each film is designated to accompany a specific chapter or chapters in the book.

It is hoped that more of these visual aids will become available, and it is presumed they will if the present three are well accepted. Debate will flourish over the merits of a film strip compared to individual projection slides. Yet the story to be told follows a logical sequence, and there are the added advantages of lower price and ease in handling. The reviewer recommends that the readers see these film strips to learn what can be done at relatively little cost to him.

I. B. HANSEN

The George Washington University

Scientists starred 1903-1943 in "American Men of Science": a study of collegiate and doctoral training, birthplace, distribution, backgrounds, and developmental influences. Stephen Sargent Visher. Baltimore: Johns Hopkins Press, 1947. Pp. xxiii + 556. (Illustrated.) $4.50.

This book possesses significance and guidance value for the postwar era of science and higher education. It is a study which should, for example, be taken into account in connection with two current proposals: (1) recommendations by the President's Commission on Higher Education to double by 1960 the Nation's present collegiate enrollment, subsidized largely on the basis of the financial need of applicants; and (2) proposed legislation to create a National Science Foundation to grant Federal collegiate scholarships and graduate fellowships in science upon the basis of competitive tests. Pertinent considerations with respect to such action are supplied in Prof. Visher's analysis of the background and training of 2,607 distinguished scientists whose work has been a vital factor in the achievements of American science during the past four decades and more.

The 2,607 scientists are the total of those listed with asterisks in the 7 editions of the directory, *American men of science,* published from 1906 to 1944. The creator of the directory was the late J. McKeen Cattell, eminent psychologist, educator, and editor of *Science.*

In the first edition, which included approximately 4,000 scientists, Cattell starred one-fourth of them as outstanding in accordance with the judgment of leading research scientists in 12 sciences, as of 1903. This system of voting by scientific peers was continued in subsequent editions. Dr. Visher does not overlook the shortcomings of the Cattell system in the light of the development of other scientific fields beyond the original 12 or of the increasing number of scientists in proportion to those starred. Nevertheless, the starred scientists do form "the largest highly and impartially selected group," and, as such, there is importance in this extensive study of their collegiate and doctoral training, their birthplaces, their distribution, their backgrounds, and their developmental influences.

Out of the wealth of deductions from the evidence Dr. Visher has assembled, the following are a few:

"It is impossible to conclude how much is biological heredity and how much is social environmental heredity." Enthusiasm for research is the one common characteristic of the group. "In other respects they differ widely. . . . Many have been highly trained, often in famous institutions; others have attended only little known and perhaps relatively weak institutions."

"Large classes and student body are unfavorable to the production of future scientists." Science students "must have intimate contact with stimulating teachers."

Qualities which the starred scientists themselves considered most significant are "perseverance, curiosity, mental alertness, initiative and critical insight."

RAYMOND WALTERS

University of Cincinnati

The scientists speak. Warren Weaver. (Ed.) New York: Boni & Gaer, 1947. Pp. xiii + 369. $3.75.

In all probability, the reader of this review heard several of the intermission science talks broadcast on the Philharmonic Symphony program during recent years. Unless he were especially unlucky, he heard good talks—sound, clear, informative, and interesting ones and, often, containing a bit of inspiration. These talks, collected in a volume, have lost none of their appeal. They constitute an impressive survey of scientific knowledge and a remarkable exhibit of science exposition.

Most authors have not been content to parade their facts but have also given some glimpse of procedures or reasoning or implications, or of the attitudes that guide a good scientist or the manner in which he operates. The "springs" of science thus lie outlined through its upholstery of accumulated information. This is rare and good in science popularization. Little is accomplished by making the public gape at faintly adumbrated wonders achieved by a modern medicine man; much, by helping people understand the importance of expertness, the power of rational experimentation, the compulsion of evidence, the dedication to impersonal ends.

The editor has given the volume continuity in two ways. First, he has grouped the 81 talks into 14 chapters, e.g. "The Science of the Earth," "Atoms and Molecules," "Science and Health," "Science and the War," "The Long-term Values," some of which are surprisingly coherent and all of which gain perspective by introductory notes. Second, he has supplied a prefatory chapter, "Science and Complexity," which outlines the history of scientific thought and method in a manner hard to surpass. Dr. Weaver presents the sequence of: "problems of simplicity," involving two or few variables, solved by the classical physical approach before this century; "problems of disorganized complexity," solved by probability theory and statistical mechanics dealing with large numbers, solved mainly after 1900; and "problems of organized complexity," those of a large but limited number of variables which interact as part of an organic

whole rather than at random, for which rigorous methods are not yet at hand. This illuminates the old and new physics and focuses attention on the relation between the sciences of the material world and those of living organisms and of human societies.

Here is an excellent volume for a scientist to give his layman friends (it includes reading lists) and—since who among us is not a layman in most of the wide stretch of science?—an excellent volume for him to read himself.

R. W. GERARD

The University of Chicago

Life: its nature and origin. Jerome Alexander. New York: Reinhold, 1948. Pages vii + 291. (Illustrated.) $5.00.

What is life? One darned thing after another; something one relaxes from on the psychoanalyst's couch; a question of importance only to an embryo; a matter of the liver; a matter of catalysis, says Dr. Alexander.

Catalysis is defined by Dr. Alexander as the process whereby a specific particulate unit or surface (the catalyst) continuously brings about chemical union, breakdown, or structural change in other units as a result of very close contact or approach. This view of the nature of life is now of respectable antiquity, and Dr. Alexander claims no title to it. Indeed, he quotes many earlier workers who have identified themselves with this viewpoint. L. P. Troland, for example, has resumed the viewpoint very clearly in his statement that "life is fundamentally a product of catalytic laws acting in colloidal systems of matter throughout long periods of geologic time." I am, however, somewhat astonished to find that the two works in which this viewpoint has been admirably presented find no mention whatever in the pages of Dr. Alexander's book. I refer to A. I. Oparin's *The origin of life* (Macmillan, 1938) and R. Beutner's *Life's beginning on earth* (Williams & Wilkins, 1938), the latter being a particularly pleasant as well as informative book. Can it be that Dr. Alexander has never heard of them?

However that may be, Dr. Alexander's book, though by no means an original contribution to the subject, is full of the most interesting and chemically recondite facts and theories. Expert and general reader alike will find the book both readable and informative. There is a brief, simple coverage of nuclear physics, with especial reference to the smallest particles of matter and the manner in which molecules make masses. The author then considers the nature of living units (bionts), and emerges with a definition of a living unit as one which can direct chemical changes by catalysis and at the same time reproduce itself by autocatalysis, as for example, genes, bacteriophages, and ultrafiltrable viruses.

The evidence, the author suggests, indicates that the primal cause of evolution is a heritable change in existing and potential biocatalysts. The discussion of this subject in relation to genetics is most stimulating.

The final chapter, "Philosophy, the Guide of Mental Life," is rather more to the point than most such concluding chapters, in which the writer frequently reminds one of the pure mathematician, referred to by Dr. Alexander, who is never so happy as when he doesn't know what he is talking about!

Dr. Alexander's book has it faults, it sometimes wanders and the reader wonders, but I hope I have said enough to indicate that it is a book very well worth reading.

M. F. ASHLEY MONTAGU

235 North 15th Street, Philadelphia

Experimental designs in social research. F. Stuart Chapin. New York-London: Harper, 1947. Pp. x + 483. $3.00.

After a preliminary characterization of experiments by "trial and error," Chapin makes a study of three types of experimental designs which he takes to be superior: (1) the "cross-sectional" (which attempts to establish present relationships), (2) the "projected" (which involves a relationship between the present and future), and (3) the "ex post facto" (which involves a relationship between the present and past). Each method is treated both in a general way and through specific illustrative research projects. The limitations and possibilities of these approaches are considered in some detail in the last two chapters. In this last portion of the book Chapin also provides a listing and classification of available types of social measurement and discusses some of the representative testing procedures.

The experimental designs are species of a methodological approach that combines J. S. Mill's *Method of Difference* and *Method of Concomitant Variations*; that is, Chapin seeks to impose controls by keeping all variables constant save one, which he attempts to "correlate" with the phenomenon in question, and thus set up causal connections. This is a restricted view of scientific method, since it fails to take into account the new methods developed to handle a large number of variables simultaneously, a method which is perhaps more suited to social research (see R. A. Fisher's *Statistical methods for research workers*). Though Chapin acknowledges the fact that complete control is impossible, he does not provide a criterion by which we can determine which are the relevant and critical variables, thus failing to account for the traditional criticism directed against Mill's methods (see, for example, *An introduction to logic and scientific method*, by Cohen and Nagel).

Chapin takes measurement to be quantification along a scale of units and then proceeds to cite many so-called psychological and sociological scales. But in considering such "measures" as are found in attitude and status studies, he fails to recognize that, although there is quantification and ordering of some sort, there is no scale, since the units of measurement are unknown. As yet there are few sociological "feet" or "pounds."

The book is important because it points out a real possibility for advance in social experimentation and directs attention to the sorely neglected study of method in the social sciences. It is questionable, however, that real advances in research can come from an analysis of method which has not absorbed such important methodological contributions as are to be found in pragmatism

(e.g. Dewey's *Logic: the theory of inquiry* or *An introduction to reflective thinking*, by the Columbia Associates) or in experimentalism (e.g. E. A. Singer, Jr., "Philosophy of Experiment," *Symposium*, I, 2).

RUSSELL L. ACKOFF

Wayne University

Our plundered planet. Fairfield Osborn. Boston: Little, Brown, 1948. Pp. xiv + 217. $2.50.

It was Fairfield Osborn's father who, some 20 years ago, called our present era the end of the age of mammals, if my memory is not tricking me. In this book the son makes compellingly clear that, in the march toward oblivion, mankind has placed itself near the head of the procession. As the only animal that deliberately destroys the environment on which its survival depends, man has used his magnificently developed forebrain to heighten the effectiveness of that destruction. The result, as Mr. Osborn shows, is a shambles; while populations increase, the means of satisfying their needs steadily diminish.

The story is told through more or less random samples that show parallel developments of the relationship between man and his environment on the five continents and Australia. Nearly everywhere man's destruction of vegetation has disrupted the hydrologic cycle, with resultant soil erosion, floods, siltation, falling water tables, vanishing wildlife—essentially, though he does not stress the fact, falling human living standards. And, as the earth disease progresses, more and more of the organism-environment is involved, and treatment and cure become more difficult and more costly.

He has assembled so many valuable data that space limitations require omission of even reference to most of them. He does an especial service by reminding us of the role of the Mesta—the Spanish Wool-growers' Association—in wrecking their country. He points out that "nature gives no blank endorsement to the profit motive" and recommends world-wide planning. He sets forth, eloquently, that "science" is not yet ready to synthesize the adequate environment visualized by some technicians and many economists; we still need the "back forty." He recognizes, as many international do-gooders still cannot, that cultural limitations prevent the use of modern technology in countries dominated by backward, illiterate, and/or exploited populations.

The reviewer has only one serious quarrel with the book: Mr. Osborn repeatedly refers to excessive populations but does not suggest doing anything about checking their increase. He makes many a convincing plea for better use of the land. The uninformed reader might conclude that improved land-use would take care of mankind, even after we were piled three deep. Direct checks on human reproduction are at least as indispensable as forest management and contour plowing.

This is a book that should be widely read; almost anyone reading it will want to recommend it to others. It tells perhaps the most important story of our day—and tells it well.

WILLIAM VOGT

Pan American Union, Washington, D. C.

Introduction to mathematical statistics. Paul G. Hoel. New York: John Wiley, 1947. Pp. x + 258.

This book furnishes a panoramic view of the aims, ideas, and methods of mathematical statistics. It "was designed to serve as a textbook for a two-semester course in mathematical statistics for which elementary calculus is a prerequisite," and in writing it an attempt was made "to keep in mind the needs of applied statisticians for a modern reference book on the fundamental methods of mathematical statistics. The material treated was selected to give the beginner a fairly broad introduction to both classical large-sample and modern small-sample methods." The author also states that "a number of topics have been treated very briefly," since he "did not care to incorporate more material than experience indicated could be satisfactorily covered in a two-semester course." As guides to supplementary reading, annotated references are provided at the end of each chapter.

Noteworthy features of this book are: (1) Its broad coverage of the ideas and techniques of statistical inference, especially those found to be most effective in industrial experimentation, quality control, and acceptance inspection. Thus, in addition to treatment of the material found in most elementary statistics texts, the reader is introduced to such topics as discriminant functions, statistical tolerance limits, and testing for randomness by runs and serial correlations. (2) The effective use made of moment-generating functions to obtain elementary proofs of many of the basic theorems of modern statistical inference. Granted certain fundamental properties of these generating functions, the proofs given are not only complete, but throw light on the character of the approximations involved, if any. (3) The collections of well-chosen exercises at the end of each chapter which provide the reader with opportunities for trying out the methods to which he has been introduced.

A major shortcoming of the book is its failure to make the reader feel "at home" in the application of the methods presented. It falls in that intermediate zone between a purely formal mathematical treatment, on the one hand, and a manual of procedures, on the other, where it is difficult to strike a satisfactory balance between mathematical rigor in the proofs and stimulating illustrations of the scope and power of the applications. The author has tended to favor rigor of development, at the expense of giving the reader a "practical feel" for the applications. As anyone who has made the attempt knows, the latter is more difficult to achieve. As W. Edw. Deming has so admirably put it, ". . . it is fairly easy to write mathematical books and papers, and even easy to make the exposition clear, but . . . it is quite a different matter to try to explain *how to use theory in practice.* This is *very difficult.*" Also, the reference material cited is insufficient and inadequately tied in with the text material. For example, in connection with discriminant functions, B. L. Welch's "Note on Discriminant Functions" (*Biometrika*, 1939, 31, 218–220) is not cited. This important note relates the problem of constructing an optimal "discriminant function" to Bayes's Theorem and to the Neyman-Pearson likelihood ratio test for

choosing between one of two admissible hypotheses, and is essential to an adequate background of the subject. In addition, the reader is occasionally left without further guidance; thus, on page 15 it is stated that the measure of skewness a_3 "can be zero without the distribution's being symmetrical," and a similar caution is given in connection with a_4 as a measure of peakedness. However, the reader is given no hints on the nature of these exceptions, to enable him to judge whether they are "pathological" or not, nor is he told where such exceptions are discussed in the literature. Explicit citation in the text of especially pertinent references given at the end of the chapter would be very helpful in numerous instances, as would also the referencing of such material in the index under author and subject.

This reviewer obtained the impression, as he read along, that he was being "talked down to." Instead of a feeling of being guided through new vistas by an enthusiastic statistician engaged in a bit of proselyting, or the feeling of being "shown the way" to a new "religion" by a penetrating thinker with wide experience, he felt that the narrator was condescending to tell him a few of the things regarded as commonplace by those "in the know."

As a textbook for a first course in mathematical statistics, its mathematical level is likely to render it unsatisfying to students of mathematics, and its atmosphere of noncontact with practical applications may limit its effectiveness among practical workers who seek on-the-job guidance. There is, however, at present no other book of comparable size that provides such a broad introduction to statistical inference.

CHURCHILL EISENHART

National Bureau of Standards

Theory of servomechanisms. Hubert M. James, Nathaniel B. Nichols, and Ralph S. Phillips. (Eds.) (Massachusetts Institute of Technology Radiation Laboratory Series.) New York-Toronto-London: McGraw-Hill, 1947. Pp. xiv + 375. (Illustrated.) $5.00.

In the first four chapters of this volume one finds a short history of servo design technique, some performance specifications, and a brief introduction to the mathematics used in the analysis of servo systems. The servo is likened to a linear filter and is characterized by either of the following: (a) its weighting function, (b) its frequency response, (c) its transfer function. Servo elements and networks are described, and Nyquist Criterion of stability is introduced. The fifth chapter deals with filters subjected to pulsed data, their transfer functions, and their stability. Pulsed servos and their characteristics are discussed in this chapter.

The last three chapters are concerned with the mathematics of statistics and statistical methods applied to control. A new design technique based on the minimum root mean square error in the presence of extraneous noises and inputs is described and applied.

There is correlation between the various chapters, and the sequence of topics discussed is well chosen. Illustrative examples and diagrams are presented throughout.

The 8 chapters of this book, written by 10 members of the Radiation Laboratory, constitute a valuable contribution to the science of servomechanisms.

E. M. SABBAGH

Purdue University

Methods of algebraic geometry. (Vol. I.) W. V. D. Hodge and D. Pedoe. Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1947. Pp. viii + 440. $6.50.

The volume before us, which, it is announced, will be followed shortly by a second volume devoted to the theory of algebraic varieties and to the study of certain loci which arise in many geometric problems, is divided into two books. Book I is devoted to Algebraic Preliminaries, and Book II, to Projective Space. As the title implies, no attempt has been made to build up a body of geometric theorems. Though the projective group is necessarily fundamental, no discussion of its invariants is given except as these may appear incidentally in reductions to canonical forms. The polar operator is mentioned, but its invariance is not stressed. Yet the necessarily restricted choice of material is excellent, and the volume is a very welcome addition to the literature in this field.

In Book I the four chapters deal, respectively, with integral domains, rings, fields, and factorization; with linear algebra, matrices, and determinants; with algebraic dependence, field extensions, and their effect on factorization; and with algebraic equations, including Hilbert's "basis" and "zero" theorems and the theory of resultants. In the second half of this book, from the point at which determinants are introduced, the basic field is assumed to be commutative. Fields with characteristic are considered only incidentally, and algebraically closed fields are employed only as circumstances demand.

In Book II, Chapters V and VI, respectively, give an algebraic and a synthetic definition of a "projective space." In these two chapters a noncommutative field is basic and commutativity is shown to be a consequence of the validity of the Pappus theorem. Essentially, the objective here is to show that the projective spaces obtained by either approach are identical. The remaining three chapters, based entirely on commutative fields, deal with Grassmann coordinates, with collineations, and with correlations including polarities and null systems. The customary reduction of pencils of such forms to canonical forms is exhaustively treated.

Much of the presentation is preliminary to Chapter VI, in which the projective space is obtained axiomatically. This particular chapter, almost one-fifth of the entire volume, seems somewhat foreign to the general purpose. Even the authors appear to share this feeling to some extent, for, in a footnote to the chapter heading, we read that "this chapter is almost completely independent of the rest of the book, and may be omitted at a first reading." Much greater unity might have been attained by omitting this chapter and using only commutative ground fields. Noncommutativity might well have been restricted to operations, such as permutations and matrix multipli-

cation, which implicitly involve it. Yet this is a matter of taste, and doubtless many readers will welcome the comparative approach.

The exposition is explicit and precise throughout. The results are obtained with a minimum of effort in notations, which in general are as convenient as the context permits. The very complete discussion of Grassmann coordinates in Chapter VII is a novel and welcome feature. The chapter on resultants and allied theorems is very effectively done, and the final chapter on correlations is unusually complete. Needless to say, the appearance of the second volume will be awaited with great interest.

ARTHUR B. COBLE

Haverford College

Integration in finite terms: Liouville's theory of elementary methods. Joseph Fels Ritt. New York: Columbia Univ. Press, 1948. Pp. vii + 100. $2.75.

Two general types of problems are discussed in this monograph, both of them closely related by the methods used: (1) When is the integral of an elementary function itself an elementary function? Here, a function is called elementary if it is constructed with a finite number of operations involving algebraic functions, exponentials, logarithms, trigonometric and inverse trigonometric functions. Of course, by Euler's relations, the trigonometric and inverse trigonometric functions can immediately be deleted from this list of basic expressions. (2) When can certain ordinary differential equations be solved by quadratures? That is, integration is now also considered an admissible elementary operation.

The study of these two types of problems was inaugurated by the great French mathematician, Joseph Liouville, who discussed such questions in 7 fundamental papers during the years 1833–41, developing quite new methods for this purpose. Only a few mathematicians continued Liouville's work; these include Chebyshev, Koenigsberger, Mordukhai-Boltovskoi, the author of this monograph, and, quite recently, Ostrowski.

In the present monograph the fascinating work of Liouville and his successors has been presented in a unified, rigorous and readable manner. The essential ideas have been stressed, and auxiliary information on analysis and algebra has been supplemented.

With regard to the first type of problems mentioned above, for example, the nonelementary character of Legendre's elliptic integrals of the first and second kinds, of the probability integral, of $\int \frac{e^x}{x}\,dx$, and of the (nonconstant) elliptic functions is proved. Among the second type of questions, Riccati and Bessel differential equations, algebraic differential equations of first order, and linear differential equations of second order are discussed. For instance, Bessel's differential equation cannot be solved by quadratures, except for special values of the parameter.

Mathematicians should certainly be indebted to the author for this very valuable monograph on such a beautiful part of analysis which, although often quoted, has been known so far only to a few specialists.

ARTHUR ROSENTHAL

Purdue University

Paramagnetic relaxation. C. J. Gorter. New York-London-Amsterdam-Brussels: Elsevier, 1947. Pp. vii + 127. (Illustrated.) $2.25.

This monograph is concerned with the frequency dependence of the magnetic susceptibility of paramagnetic salts. Prof. Gorter, now director of the Kamerlingh Onnes Laboratory at Leiden, was the first to explore this field and remains its leading experimental investigator. Most physicists and chemists are familiar with dielectric dispersion and absorption in polar substances. The magnetic analogue of this phenomenon, which we meet here, presents a much more complicated picture. The variables at the disposal of the experimenter are the temperature, the frequency of the oscillating magnetic field, and the intensity of a constant magnetic field applied to the specimen. (The important role of the last parameter has no analogue in dielectric relaxation.) The reader new to the field may find the wealth of experimental data assembled in Chapter III a bit bewildering, even after the succinct and illuminating review of static paramagnetism and the thermodynamics of a paramagnetic system contained in the first two chapters. The theoretical discussion of the phenomena observed is reserved for Chapter IV. On all but pedagogical grounds, the author's emphasis on the experimental results is certainly justified. Indeed, theory has by no means caught up to experiment in this field, despite the notable contributions of Van Vleck, in this country, and Casimir, Kronig, Broer, and others in Holland. The subject is very much alive, and Prof. Gorter's authoritative book, written during the dark days of the German occupation, represents a consolidation of ground gained in preparation for fresh assaults.

E. M. PURCELL

Harvard University

New developments in ferromagnetic materials, with introductory chapters on the statics and the dynamics of ferromagnetism. J. L. Snoek. New York-Amsterdam: Elsevier, 1947. Pp. viii + 136. $2.50.

This small book is intended to summarize the research on ferromagnetic materials carried out by Snoek and his co-workers during the war at the Phillips Laboratory in the Netherlands. This group was able to continue under the hazards and inconveniences that accompanied the German occupation and added a very interesting chapter to the subject of ferromagnetism.

Snoek has divided the monograph into three parts: I, Statics of Ferromagnetism; II, Dynamics of Ferromagnetism; III, Development of Ferromagnetic Materials. The first of these parts deals with new discoveries and new viewpoints concerning the properties of ferromagnetic materials under conditions in which

the applied magnetic field is stationary or is varied very slowly. The topics covered are miscellaneous and center about such subjects as the theory of the hysteresis curve, measurements of crystal anisotropy and magnetostriction in ternary alloys, and the permeability and coercive force in the cubic ferromagnetic oxides. The investigation of the magnetic oxides represents the profitable renaissance of a subject that has barely been touched in the past.

The second part, dealing with the dynamics of ferromagnetism, summarizes that class of magnetic properties of steel and related substances which vary with time as a result of the diffusion of the interstitial carbon or nitrogen atoms. One of the most conspicuous of these effects is the decrease with time of the permeability that is observed following a change in magnetization—an effect to which Snoek has given the name "disaccommodation." Snoek presents a closely correlated group of experiments concerning this and related effects and summarizes the very beautiful theory with which he has interpreted the observations.

The third section surveys in considerable detail the properties of the mixed ferromagnetic oxides or "ferrites" which were touched upon in the first part of the book. The influence of temperature and composition are treated. For example, the variation of the Curie temperature with composition is followed for a number of continously varying systems. In addition, there is much magnetic data of technical interest concerning these oxides.

It is safe to say that this small book represents one of the most valuable additions to the subject of ferromagnetism since the volume of Becker and Döring appeared nearly 10 years ago.

FREDERICK SEITZ

Carnegie Institute of Technology

Nuclear physics in photographs: tracks of charged particles in photographic emulsions. C. F. Powell and G. P. S. Occhialini. Oxford, Engl.: Clarendon Press; New York: Oxford Univ. Press, 1947. Pp. xii + 124. $6.00.

One of the oldest and simplest techniques in nuclear physics which has been 'dormant'' for many years has suddenly, through some important refinements, come to the forefront of the attention of physicists. Indeed, it has allowed, by the simplest methods, some of the most important postwar discoveries.

The history of the revelation of *tracks* in photographic emulsions is a very old one, going back to Kinoshita in 1909, but before its present blossoming, in part due to the new Ilford and Eastman emulsions, it had not given any results of importance comparable with those reached through the electrical methods of measuring, scintillations or Wilson Chamber.

The book under review shows in an exceedingly beautiful way what can be done at present with photographic emulsions. In this respect it is comparable to the Atlas of Wilson Chamber pictures by Gentner, Maier Leibnitz, and Bothe.

A sequence of striking pictures of nuclear phenomena as revealed by the technique of the tracks in photographic emulsions is used to illustrate an elementary course in nuclear and cosmic-ray physics, but this arrangement and the well-written text is only, one feels, a convenient frame to illustrate the technique.

The climax is reached in plates 42–48, in which evidence is given for the new π mesotrons recently discovered with this technique by a group of physicists, including the authors of this book.

The book contains sufficient technical information to instruct on the methods of use of the photographic plates, which are now commercially available, and, if only for this reason, it is a "must" for every research nuclear physicist.

The reproduction of the photographs and the typographical presentation are excellent—a most important feature for a book of this kind.

E. SEGRÈ

University of California, Berkeley

Techniques in experimental electronics. C. H. Bachman. New York: John Wiley; London: Chapman & Hall, 1948. Pp. vii + 252. (Illustrated.) $3.50.

Asked individually what they would expect to find in a book entitled *Techniques in experimental electronics*, 10 well-qualified persons, including physicists, radio engineers, electronic research engineers, and graduate students in physics, all thought that such a book would include vacuum tube circuits, discussions of electronic measurement methods, and the many other techniques familiarly known as electronic gadgeteering.

C. H. Bachman's book of the above title is, instead, a very good handbook of high-vacuum techniques and of the laboratory arts useful to those who build experimental electron tubes and related electron and ion systems.

One must consequently conclude that the title of the volume is badly chosen, despite the technical justification for the name offered in the introduction. Undoubtedly, many will purchase the book and find it of little use, while others having need of this material will pass it over.

Slightly more than half of the book is devoted to high-vacuum techniques, chapters including pumps, traps and baffles, vacuum gauges, valves and controlled leaks, demountable joints, controls and gadgets, vacuum system techniques, leak detection, and metal versus glass vacuum systems. Other chapter headings are glass-blowing fundamentals, sources of charged particles, utilization of charged particles, assembly and processing of electronic devices, and miscellaneous hints and techniques.

The treatment of high-vacuum techniques is simple and direct and filled with useful practical facts. Gauges are covered a little too sketchily for a novice in the field, and little is said of the temporary vacuum systems utilizing spherical ground joints and flexible tubing, now gaining wide acceptance.

The sections on filaments and cathodes, on electron guns and electron optics, and on ion sources are adequate

and well written. The data on fluorescent screens is outstandingly good.

It is unfortunate that the rubber sheet and the electrolytic tank methods for experimental determination of electrode shapes have been omitted.

Techniques in experimental electronics is directly comparable to the well-known book by Strong, *Procedures in experimental physics.* Strong's book covers a very wide field of techniques quite adequately but is in consequence a little spotty. It has also become a little obsolescent in 10 years without revision. Bachman's book is fresh, concise, and coherent, but limited in scope.

OTTO H. SCHMITT
University of Minnesota

Radar beacons. Arthur Roberts. (Ed.) (Massachusetts Institute of Technology Radiation Laboratory Series.) New York-London: McGraw-Hill, 1947. Pp. xx + 489. (Illustrated.) $6.00.

Radar beacons, the third volume in the 28-volume Radiation Laboratory Series, summarizes the work of Division 7 of the Radiation Laboratory during the war, and it is believed to be the only book on this subject ever written. L. A. Turner was head of this division, with A. Roberts and M. D. O'Day serving as group leaders. The book lists 8 additional members of the editorial staff and 21 additional contributing authors. It is well illustrated with 246 figures, including numerous block and circuit diagrams and many photographs of complete beacon systems.

The volume is divided into four parts: (I) Basic Considerations, Chapters 1–6; (II) Beacon Design, Chapters 7–16; (III) Interrogator and System Design, Chapters 17–19; and (IV) Beacons in the Field, Chapter 20. Approximately one-quarter of the book is devoted to Part I, one-half to Part II, and one-quarter to Parts III and IV. The book is thus intended primarily for design engineers rather than for operational staff. For example, the amazingly large number of military uses of radar beacons are mentioned only briefly. Presumably much of this information is still classified. For all radar engineers, as well as for the highly specialized beacon engineer, the book would seem to be indispensable, since a radar designed without a full appreciation of beacon problems can hardly be expected to give completely satisfactory beacon performance. Most radars, whether ground, ship, or airborne, have found increased usefulness when provision is made for beacon operation.

The first chapter, written by L. A. Turner and A. Roberts, describes the uses of beacons. Though brief, it is a remarkably clear account of the way radar beacons were adapted during the war, first to defensive operations (submarine hunting) and later to offensive operations (strategic and tactical bombing). From the many uses of beacons one must indeed agree that "they also serve who only stand and wait."

The 5 remaining chapters of the first part treat such basic considerations as range, coverage, frequency, coding, and traffic capacity. The next 10 chapters, forming the second part, consider in detail the design of the many radar components peculiar to beacons, such as discriminators, coders, and special types of transmitters, receivers, antennas, and control devices. Chapters 17 and 18 are devoted to interrogator design and would be of particular interest to engineers designing radars. Chapter 19 describes complete beacon systems now available and the performance to be expected of such complete systems, while the final chapter discusses the installation, operation, and maintenance of beacons.

G. C. DANIELSON
Bell Telephone Laboratories, Murray Hill, New Jersey

Vacuum tubes. Karl R. Spangenberg. New York-Toronto-London: McGraw-Hill, 1948. Pp. xvii + 860. (Illustrated.) $7.50.

This is an excellent textbook for early graduate or late undergraduate study of vacuum tubes—of vacuum tubes alone. Circuits and gas phenomena are hardly mentioned, but the treatment of vacuum tubes, from diodes, triodes, tetrodes, and pentodes through cathode-ray tubes and photocells to klystrons, magnetrons, and "special" tubes is modern and penetrating.

The author says in the preface: "It is hoped that the view taken will be acceptable to both physicists and engineers." It should be, because the book is a reflection of the continuous struggle between the analytical and the experimental methods of advancing the subject matter. For example, in the chapters on "Determination of Potential Fields" and "Laws of Electron Motion," analytical expressions, which include relativistic masses and energies, are developed for the trajectories of charged particles in comparatively simple cases of electric and magnetic field configurations. Then, in order to handle the complicated electrode structures, those overbelittled "ingenious gadjets" are described, such as elastic-membrane and current-flow models and the graphical methods for determining electron paths. Theory and experimentation follow each other in this book just as they do in the development, design, and use of vacuum tubes.

After considerable attention to the physical principles, emphasis is shifted to the design and utilization of the tubes. There are numerous nomographs, design charts, field configurations, and a chapter on high-vacuum practice. There are 216 problems and excellent references to books and original papers to provide stimulus to the student. The rationalized MKS system of units is used throughout.

The book is especially outstanding for its chapters on Tetrodes, Pentodes, Tube Noise, Klystrons, and Magnetrons. There is much material presented here in textbook form for the first time.

The index seems to be too brief. Mention of Hull and Williams in connection with the early work on the screen-grid-tube seems to be missing. But the book is largely free from errors and the format is excellent. It is the second in the publisher's "Electrical and Electronic Engineering Series," the first of which is the well-known text, *Radio engineering,* by F. E. Terman.

J. BARTON HOAG
U. S. Coast Guard Academy, New London, Connecticut

Crystal rectifiers. Henry C. Torrey and Charles A. Whitmer. (Ed. by S. A. Goudsmit, *et al.*) (Massachusetts Institute of Technology Radiation Laboratory Series.) New York-London: McGraw-Hill, 1948. Pp. xiii + 443. (Illustrated.) $6.00.

Under the sponsorship of the Office of Scientific Research and Development, members of the staff of the Radiation Laboratory of the Massachusetts Institute of Technology undertook the compilation of a series of books reviewing World War II research and development programs in which the Radiation Laboratory had been actively engaged. *Crystal rectifiers* is one of this series. The scope of the book is not restricted to Radiation Laboratory projects, and the attempt is to encompass all contemporary effort devoted to the development of crystal rectifiers during the war, including some information concerning related activities in England. It is to be assumed that all work was closely coordinated.

After indicating the renewed importance of the crystal rectifier since the development of microwave radar, the authors summarize the results of crystal rectifier development effort in the following words appearing in the preface of this book: "As a result, the crystal rectifier unit that has emerged is a compact, stable device which is superior in many applications to the vacuum tube diode. Its most extensive use up to now has been as a frequency converter in microwave reception, where its performance has not been equaled. It has also been used to a lesser extent as a low-level microwave detector."

The authors give very interesting discussions of the theory of conduction in semiconductors and of rectification at the contact between a metal and a semiconductor. Analytical studies involved the use of an admittance matrix in terms of signal, intermediate, and other frequencies. Effects of the nonlinear characteristics of crystal rectifiers are treated, although, as may be expected, the treatment becomes unwieldy and involved.

The book is well and carefully written. The very large amount of material is well arranged and makes interesting reading. The text covers the very interesting development aspects and manufacturing techniques, in addition to the theoretical and research work on crystal rectifiers. This book would be of interest to those engaged in microwave research and development in educational, governmental, commercial, and other institutions or agencies.

Most of the references are to reports made by wartime contractors, access to which may be found difficult in many cases. However, as the text appears to be very complete, this may not be a serious complaint. The value of the book might have been greatly improved had the authors attempted to give their appraisal of the most promising avenues for continued research in the field of crystal rectifiers. A perusal of the book indicates, for instance, that further analytical studies of the rectifiers from the point of view of quantum mechanics would be highly profitable and might conceivably be a means of contributing to our knowledge of the solid state.

R. B. WRIGHT
Research and Development Board, Washington, D. C.

Powder metallurgy: its physics and production. Paul Schwarzkopf. New York: Macmillan, 1947. Pp. xii + 379. (Illustrated.) $8.00.

Powder metallurgy: its physics and productivity is an outstanding contribution to this field, covering as it does, all branches of this subject, including ferrous, nonferrous, highly porous and dense, friction hard metals, and refractories. The author is quite thorough.

In powder metallurgy the metal powders, or raw materials, are of primary importance. Frequently, they can be produced by various methods or processes, each of which are fully described. Particle characteristics and their influence are a major factor, and all of these are treated. Since copper powder and iron powder are used by industry in the largest volume, the genesis and behavior of these two materials have been especially emphasized.

From metal powders the reader progresses by logical steps, and in a very interesting manner, through the various subsequent operations in their natural sequence. Compacting, or briquetting, is outlined, as are the different types of briquetting presses and die sets. The die design and procedure for making both simple and complex briquettes or compacts is well illustrated.

Sintering methods and equipment are delineated along with the effects of temperature and time, particularly with reference to growth and physical values. Reducing atmospheres, their properties, control, and influence are described.

In the chapter on re-pressing or sizing, equipment, tooling, and the effect of normal variables, as well as their influence upon the end-product, including strength and ductility, are shown.

In powder metallurgy, porous units for self-lubrication or other service are desirable as well as units of high density for superior physical properties. Cognizance is taken of the fact that, for the latter group, different methods may be employed. All of these and attending factors are treated with respect to end-results.

Powder metallurgy products are unique in that some cannot be produced by any other methods, while others are in competition with solid or reguline materials. The latter is a relatively more recent development as compared to the manufacture of porous, self-lubricating bearings or hard-metal cutting tools. Special processing is involved, and these as well as the effect are fully described and illustrated. The production of hard metals, friction members, and such specialties as contact points, radio cores, and magnets is fully covered.

The author's style inspires confidence, and throughout the book an unusual mixture of practice and theory is presented in a coherent manner. Schwarzkopf devotes considerable space to the purely theoretical aspect of powder metallurgy, and here, too, there is an infiltration of the practical. The book is replete with informative charts, data, photos, references, and bibliography. Theories advanced by other authors, principally on sintering and compacting, are stated clearly and accurately. In a charming manner, the author credits early investigators, other works, contributors, and colleagues.

This book is excellent indeed and well suited for engi-

neers in general and specifically for metallurgists so engaged. It has the points of a good textbook and is eminently suited for postgraduate work.

A. J. LANGHAMMER

Detroit, Michigan

Seventy-five years of progress in the mineral industry (1871-1946). A. B. Parsons. (Ed.) New York: American Institute of Mining and Metallurgical Engineers, 1947. Pp. xii + 817. (Illustrated.) $6.00.

The rising curve of production and scientific development in this country has ascended far above the levels prevailing in May 1871, when the American Institute of Mining and Metallurgical Engineers was founded in Wilkes-Barre, Pennsylvania. Annual mineral production in the United States has increased 10 times during this 75-year period. With only about one-sixteenth of the world's people, the United States now consumes nearly half of the world's mineral output. The heavy drain on the mineral resources of this country during the recent war made the World Conference on Mineral Resources, which was held in celebration of the 75th Founder's Day of the AIME, particularly timely. This is the anniversary volume commemorating this significant event. It is composed of historical papers wherein experts in the fields of mining and metallurgy have reviewed significant developments in mining geology (L. C. Graton), metal mining (Lucie-Eaton), ore dressing (A. F. Taggart), smelting and leaching of ores (F. Leist), iron and steel (C. D. King), nonferrous metallurgy (W. M. Pierce), bituminous coal mining (H. N. Eaverson), anthracite industry (C. Evans, *et al.*), petroleum (E. L. DeGolyer), nonmetallics (Oliver Bowles), and in mineral industry education (T. T. Read). These chapters are not mere rehearsals of historical fact. They are, as the editor, who is executive secretary of the AIME, states, "99 percent fact, with just enough fancy to season it to the taste of the average engineer."

Considering the scientific and industrial developments of the period covered by this volume and the dependence which these have had on mineral raw materials, it is remarkable that this amazing amount of material could be so adequately covered in a single volume, even one of 800 pages. The value of such a volume, however, rests not so much on the quantity of the material presented as it does upon the ability of its authors to sift the significant from the unimportant. In this respect the volume doubtless sets a new high, for probably a more imposing galaxy of authorities could not have been assembled. This comment holds also for the second part of the volume, which contains the proceedings of the World Conference on Mineral Resources. Particularly significant are the articles on "The Mineral Position of the United States," by the Secretary of the Interior, J. A. Krug, "Iron Ore and the Steel Industry" (Charles M. White), "International Aspects of the Petroleum Industry" (Sir William Fraser), "The Future of Gold in World Economy" (P. M. Anderson), "World Coal Resources" (C. Augustus Carlow), "The Role of the Engineer in the Development of Atomic Energy" (P. C. Keith), "Application of Atomic Energy to Industry" (H. A. Winne and B. R. Prentice), and "Metals and Alloys" (Zoy Jeffries), to mention only a few.

The volume is not overburdened with statistics, but in a chapter by E. W. Pehrson, chief of the Mineral Economics Branch, U. S. Bureau of Mines, one finds the entire 75-year statistical record presented in neat, easily digested capsules, each containing one mineral commodity. Pehrson reminds us that in the 75 years covered by this volume total mineral production in this country has increased in value from less than $500,000,000 in 1880 to over $8,500,000,000 in 1945. "In 1870 mineral fuels comprised 38 percent of the total value of all mineral products, metals 52%, and non-metallic minerals 10%." In 1946 the fuels had increased to 64%, metals had decreased to 21%, and nonmetals to 15%.

The World Mineral Conference reports, comprising approximately 50% of the volume, present the most up-to-date review of the international mineral situation available. In the volume, as during the Conference itself, the discussions of atomic power and new sources of gasoline attracted greatest attention. The principles of the nuclear reactor as a source of power are outlined, and a diagram of an atomic power plant is shown (p. 710). The hope of obtaining usable electric power directly from an atomic pile, however, is dispelled. It is concluded that "the atomic energy will appear as heat, which, when converted into steam or hot gas, will feed conventional turbo generators" (p. 714). The use of ". . . atomic power plants for large naval and commercial ocean vessels looks definitely possible, and attractive from the standpoint of making refueling extremely infrequent. This may well be the first real commercial application" (p. 716).

This valuable volume should serve as a reliable reference book for all persons interested in the vast mineral industry. Physically, the volume maintains the same high standard characteristic of all publications of the AIME. Written by more than 25 authors, the volume has remarkable continuity of subject matter. This is a tribute to the editor and his staff.

RUSSELL S. POOR

Alabama Polytechnic Institute

Angewandte Hydraulik. Robert Dubs. Zurich, Switzerland: Rascher Verlag, 1947. Pp. viii + 408. (Illustrated.)

The author, at present professor at the Federal Technical Institute (E.T.H.), Zurich, Switzerland, has set the aim of writing a book which would embrace "possibly all of the hydraulic problems" facing the engineer practicing in the mechanical field. It may be assumed that the book reflects also the character of instruction offered on the subject at the Zurich Polytechnicum.

As a matter of fact, the principal interest of the book for the American reader lies in comparing the manner of approach followed by Prof. Dubs's text with the trends prevailing in American engineering. It has become customary in this country to supply the engineer with a broad knowledge of fundamental principles and facts

governing the behavior of fluids, with proper emphasis on the more recent advances in the domain of so-called fluid mechanics. Scarcely any of these novel concepts are used or referred to in the book under review. In fact, after an introductory chapter which sets forth in a very clear, although somewhat elementary, manner the basis of old-fashioned hydraulic theory, the volume concentrates on a detailed treatment of certain engineering applications. There again the title *Applied hydraulics* appears to be broader than the actual contents of the volume. In fact, the selection of the subject matter is substantially limited to the requirements of the mechanical engineer specializing in water power. Open channel flow, weirs, and hydraulic structures are omitted. The emphasis is laid on pipe hydraulics, water hammer, and surge tanks, with a closing chapter on hydrometry. In his treatment of these subjects Prof. Dubs avoids general principles and follows mostly what may be termed a semiempirical course, gradually building up his presentation from the most elementary concepts. The author has succeeded well in his limited task. Also, the usefulness of the book is enhanced by the disclosure of valuable experimental data obtained in the Institute for Hydraulics and Hydraulic Machinery of the Zurich Polytechnicum, of which Prof. Dubs is director.

The eventual difference between the modes of apprenticing the engineer for professional work in different countries offers useful material for thought and comparison. Switzerland, with the preponderant role of water power, naturally requires much of its engineering talent to be specially trained for that field. The country, with its highly competitive position, may naturally prefer early and narrow specialization. By concentrating instruction on certain selected fields, a substantial level of professional competence may be reached at the school level, making the graduating engineer ready to perform responsible technical work of a kind which, in other countries, may require years of practical apprenticeship in industry or in the field.

B. A. BAKHMETEFF

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Heat. Archie G. Worthing and David Halliday. New York: John Wiley; London: Chapman & Hall, 1948. Pp. xii + 522. (Illustrated.) $6.00.

This book, as stated in the preface, is intended as a text for second-year work in physics and for an advance course for college seniors and early graduate students. Unless this reviewer has entirely forgotten his experience in a second-year course in physics, present-day juniors are much better prepared than they were a generation or more ago!

In the 522 pages of this book the authors have covered the field generally considered under "Heat." The subjects treated, with a chapter devoted to each are: Temperature, Thermal Expansion, Theory of Heat, Calorimetry, Specific Heats, Thermal Conduction, Thermal Properties of Gases, Elementary Thermodynamics, Change of Phase, Heat Engines and Refrigerators, Convection, and Radiant Energy. The first chapter is concerned with Laboratory Procedure and might well be a first chapter in any (or all) advanced books on physics. This chapter seems to show some of the experiences of the senior author with younger men in his earlier work in an industrial laboratory.

Each chapter is followed by a number of problems—over 200 in all—that well illustrate some of the principles discussed.

As a help to the student there are four appendices. The first gives a derivation of the Maxwell velocity distribution law for gases, the second consists of a number of tables of data, the third is made up of tables of both natural and common logarithms, and the fourth is a discussion of the properties of determinants.

The authors make their statements exact and precise in order to avoid, as far as possible, the loose usage sometimes found. Following this idea, they have employed, as far as possible, the standard nomenclature that has been adopted by the American Standards Association. In this they are careful to use terms and endings that distinguish between the properties of a body and of a material. However, when they think the gain in ease of understanding and freedom from confusion warrants, they do not hesitate to introduce new terms. An example of this is their use of the word "massing" for weighing for a determination of the mass of a body. Also, since the word pound is used in two senses, *i.e.* as a unit of mass and as a unit of force, they use the abbreviation pd for the mass and lb for the force.

A valuable feature of the book is the combination of theory, practical examples, and methods of measuring the various characteristics. There are many illustrations—about 250 in all—in this well-printed book which is remarkably free from errors.

This book promises to fill a need in the field of second-year physics.

W. E. FORSYTHE

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Chemical process principles. Pt. II: *Thermodynamics*; Pt. III: *Kinetics and catalysis.* Olaf A. Hougen and Kenneth M. Watson. New York: John Wiley; London: Chapman & Hall, 1947. Pt. II: Pp. xv + 437–804 + xlviii. $5.00. Pt. III: Pp. xv + 805–1107 + xlviii. $4.50.

The problems of the chemical engineer fall broadly into three classes: first, developing the process; second, planning the equipment for carrying it out; and third, designing a coordinated plant. The two latter problems are essentially physical and mechanical, but the first involves a thorough understanding of chemical and, in particular, physicochemical principles. The purpose of the work under review is to give "an intensive quantitative training in the practical applications of the principles of physical chemistry to the solution of complicated industrial problems" and, through recent developments in thermodynamics and kinetics, to integrate these principles "into procedures for process design and analysis."

The first part of *Chemical process principles*, published in 1943, deals with material and energy balances; the second and third parts, recently issued, cover various

aspects of the second and third laws of thermodynamics and of reaction kinetics, respectively. Although the three parts are bound separately, they are to be regarded as portions of a single work, for the paging and the numbering of figures and tables is continuous. They are shortly to be available as a single volume which, although somewhat bulky, will have the advantage of facilitating cross references. The chapter headings in Part II are: "Thermodynamic Principles," "Thermodynamic Properties of Fluids," "Expansion and Compression of Fluids," "Thermodynamics of Solutions," "Physical Equilibrium," "Chemical Equilibrium," and "Thermodynamic Properties From Molecular Structure"; those in Part III are: "Homogeneous Reactions," "Catalytic Reactions," "Mass and Heat Transfer in Catalytic Beds," "Catalytic Reactor Design," and "Uncatalyzed Heterogeneous Reactions."

It should be pointed out, however, that the bare recital of these titles gives but a slight idea of the wealth of material, much of it original and not available elsewhere, that is contained in these books. Among the outstanding features are the worked examples which serve to illustrate the principles developed in the text; these are often given with considerable detail, including graphs and tabulations of results. Somewhat analogous problems, for solution by the student, are provided at the end of each chapter. In general, these are adequate in both number and variety, although a few more exercises on the calculation of thermodynamic properties (Chap. XVII) would be welcome. The usefulness of the books, in this connection, would be enhanced if the excellent table of standard entropies in Part II were supplemented by corresponding compilations of heats and free energies of formation, as well as of heat capacities. The thermal data are mostly in Part I, and free energies are not tabulated; these can, of course, be calculated from the information given.

A notable aspect of Part II is the extensive use of the so-called "generalized procedures," based on the law of corresponding states, for deriving many physical properties of liquids and gases. Although the results are admittedly approximate, they can be very useful, at least as a rough guide, when reliable experimental values are not available. The use of partition functions for calculating thermodynamic properties of gaseous substances is also described in a clear and concise manner.

In spite of the somewhat uneven quality of the paper, which is a sign of the times, the publishers have done their part commendably, the many diagrams being particularly well drawn and printed. The authors have performed the difficult proof reading with care; very few typographical errors have been noted, and, with the exception of those in Table LVI (p. 893), they are of trivial nature. In conclusion, it may be said that *Chemical process principles* is a work which can be highly recommended for study by chemical engineers; physical chemists should read it so that they may become more fully aware of the practical applications of their apparently theoretical studies.

SAMUEL GLASSTONE

Boston College

High polymers. Vol. VI: ***Mechanical behavior of high polymers.*** Turner Alfrey, Jr. New York-London: Interscience, 1948. Pp. xiv + 581. (Illustrated.) $9.50.

Theoretical problems of elasticity and viscosity, from the molecular viewpoint, assume special forms in the case of high polymers because of the complexity and randomness of the molecular structure. This peculiarity is at once a severe difficulty, making exact analysis tremendously complicated, and a simplifying feature, permitting certain results to be obtained from approximate statistical procedures. These simplified analyses have been carried to such a point that it is now possible to assemble a coherent theoretical picture of the mechanical behavior of high polymers which is, on the whole, satisfying, even though details are admittedly lacking. In his new book Alfrey attempts with a high degree of success to assemble this over-all picture.

The Alfrey book represents the first large-scale effort to collect and to unify the accumulated results concerning mechanical properties of high polymers and is thus a significant advance in the field of polymer science. The general approach is theoretical. Most topics are introduced by a description of a phenomenon in terms of a mechanical model or in terms of molecular structure. Such experimental evidence as is available generally follows this initial discussion. Thus, in some cases the discussion of experimental results is fitted onto the conceptual scheme of the theory. In view of the still incomplete nature of the theory, some readers might prefer that experimental results be presented independently first, but this procedure would complicate what is already a work of ambitious length. The scheme used has the merit of unifying the material more nearly around central concepts.

The wide range of subjects treated includes plastoelastic behavior of amorphous linear high polymers and of three-dimensional cross-linked polymers, crystallization, plasticization, the behavior of polymers in solution, and ultimate strength. There is a considerable quantity of work previously unpublished, including an original theory of the plastoelastic spectrum of an amorphous linear polymer. An effort has been made to concentrate upon topics which have received both theoretical and experimental attention. Even so, there is sometimes a paucity of relevant experimental work. This is largely unavoidable because the field is new and because a great deal of the recorded experimental effort has been directed toward commercial end-products. The response of high polymers to sinusoidal forces is not treated extensively, probably because few experimental results were available. The volume includes much background material, most of which is closely connected with the central subject matter. Summaries of descriptive elasticity, of the chemical formation of three-dimensional polymers, and of modern theories of liquid flow are included.

The book should be of interest and of value to all theoretical and experimental research workers concerned with high polymers. Extensive bibliographies at the ends of the chapters increase the usefulness of the work (although graphs and data tables are not always clearly

labeled as to source). A body of admittedly speculative material is included, but in the present state of the art some speculation may be allowed in an effort to produce a coherent work and to stimulate further research. This volume is not intended to constitute a textbook or handbook of the properties of available polymeric materials; rather, it is intended for those readers whose aim is to understand the mechanisms of high polymer behavior.

A. W. NOLLE

University of Texas

Frontiers in chemistry. Vol. V: ***Chemical architecture.*** R. E. Burk and Oliver Grummitt. (Eds.) New York-London: Interscience, 1948. Pp. 202. (Illustrated.) $4.50.

This volume is a continuation of the publication of the annual series of lectures, under the general title "Frontiers in Chemistry," sponsored by the Graduate School of Western Reserve University. Two series of lectures have been given in the spring of each year. Series I and II were given in 1942, and Volumes I and II were published the year following their presentation. Volumes V and VI, however, are appearing nearly four years after the presentation of the lectures, presumably because of the difficult conditions created by the late war. The reviewer earnestly recommends to the editors and publishers of this series that every effort be made to have the volumes appear not later than one year following presentation of the lectures. This will preserve the timeliness of the topics and enhance the importance of the material discussed. Since the beginning of these lectures in 1942, several similar projects have been started at various other universities and institutions. In the words of the editors, this is "both encouraging and flattering, and we hope that the trend will continue. Continued success depends upon the quality of the lectures and on well-organized programs."

In this volume, the several topics are presented by masters in their respective fields, as follows:

In "Application of Molecular Geometry in the Field of Reaction Mechanism," by Hugh S. Taylor, we find a discussion of the concept of activation energy, and the influence and effect of molecular geometry in homogeneous reactions, in heterogeneous reactions, and in homogeneous liquid systems.

"Dipole Moment, Resonance, and Molecular Structure," by Charles P. Smyth, considers the molecule as an electric dipole, experimental determination of dipole moments, use of dipole moment in determining molecular structure, movable dipoles and restricted rotation, and the dipole moment as a measure of resonance.

The subject "Structure of Coordination Compounds" is taken up by W. Conrad Fernelius. In the field of inorganic compounds, Fernelius discusses fundamental definitions, the nature of coordination linkages, and methods for deducing the structure of inorganic molecules.

"X-Ray Studies of Randomness in Various Materials," by Bertram E. Warren, deals with the structures of ideally crystalline materials and randomness in the structure of other materials.

In "Light Scattering in Polymer Solutions," H. Mark discusses a few principles of light scattering, the scattering of light from a pure liquid, from solutions of small molecules, and from solutions containing particles comparable with the wave length of light, the depolarization of scattered light, and experimental methods for measuring turbidity and disymmetry.

Miroslav W. Tamele, in "The Nature of Inorganic Gels," discusses the definition of gel, the formation of inorganic gels, inorganic sols, sol-gel transformation, structural changes on drying of gels, the solid framework of dried gels, and the porosity of gels.

Adequate references are given at the end of each chapter. The reviewer wishes that one additional subject had been included in this volume, namely, "molecular architecture in the statistical calculation of thermodynamic functions."

A copy of this book should be available in the library of every scientific or technical laboratory, so that its chemists and chemical physicists may see how important is the concept of molecular architecture in the analysis of the diverse problems discussed by the authors of this volume.

FREDERICK D. ROSSINI

National Bureau of Standards

Topics in physical chemistry: a supplementary text for students of medicine. W. Mansfield Clark. Baltimore: Williams & Wilkins, 1948. Pp. xv + 738. (Illustrated.) $10.00.

The purpose of this book is best described in the author's own words in the preface: "This book is not designed as a text for a formal course. It is written to meet the diverse needs of medical students and to be drawn upon as the student of elementary biochemistry and the maturing student of medicine may find occasion." The reviewer may add this: the book shows the mark of an experienced teacher of biochemistry in a medical school, whose personal interest is especially inclined to the physicochemical aspects, and whose own line of research is not so much concerned with new discoveries, such as new vitamins or enzymes, which have to wait for a rational understanding, as with the advancement of his science by the application and extension of acknowledged fundamental principles of physics and chemistry under the guidance of both a clear ideology and a scrupulously devised technique.

In order to give the reader a useful presentation of the matter, the author clearly recognizes that there are certain things that must be dealt with from the very bottom, and for which a profound understanding of the fundamental definitions and principles is the most necessary requisite. He recognizes also that there are many other things which are just as important, but of such a nature that the medical student, who, after all, is not a physicist or mathematician, cannot be expected to be sufficiently prepared to follow all the steps of argumentations from what the physicist would consider the bottom. Also, the mathematical part of the exposition, which is, of course, not entirely avoidable in a book on physicochemistry,

shows marks of such a duality: it is very strict in certain aspects; in others, the formulas are merely taken over without any attempts being made to derive them rationally (e.g. Stokes' law of sedimentation, the Debye-Hückel limiting laws, and the whole chapter on the chemical bond and resonance).

The 30 chapters cover the following topics: limiting laws; review of certain indispensable conventions; the standard chemical balance; measurements of volume; density and some of its clinical uses; sedimentation in gravitational and centrifugal fields; limiting laws of gases; colligative properties of solutions; distribution between phases; diffusion; impressionistic sketches of phenomena associated with semipermeable membranes; mass action law; rates of reaction; equilibrium in systems containing hemoglobin; conductance; proton exchange, pH; certain properties of protein solutions; equilibrium of blood electrolytes; thermochemistry; free energy; oxidation-reduction; glass electrode; polarography; a picture of atomic structure; isotopes; refraction and polarization of light; stereoisomerism; emission and absorption spectra; luminescence; and a few topics of colloid chemistry. There are several appendices. Each of the 30 chapters is seasoned by a motto, a quotation from authors ranging from an ancient emperor of Hindustan to the heroes of modern science.

It will indeed be a good investment of leisure hours for a medical student, not only while at medical school but even more so thereafter, to study this book chapter by chapter—for study, he must; it is no easy reading matter. He will learn something both from those chapters which try to inculcate the fundamentals and from those representing just impressionistic sketches, and he will find the satisfaction, from his standpoint as a medical man, that at all times the application of the particular topic to physiological and clinical problems is emphasized.

L. MICHAELIS
The Rockefeller Institute for Medical Research

Selected values of properties of hydrocarbons. Frederick D. Rossini, *et al.* (Circular of the National Bureau of Standards C461; prepared as part of the work of the American Petroleum Institute Research Project 44.) Washington, D. C.: U. S. Government Printing Office, 1947. Pp. xiii + 483. $2.75.

Twenty years ago no one was particularly concerned with the physical properties of hydrocarbons. At that time, with the exception of aromatics, the hydrocarbons were used mainly as a convenient starting basis for the study of organic chemistry. Since then, the widespread use of hydrocarbons in production of high-octane motor fuel, synthetic rubber, and chemicals has necessitated a critical evaluation of their physical properties. This book is therefore extremely appropriate and timely, representing, as it does, a fundamental study of this fundamental subject.

This volume is the result of a special project sponsored by the government and enthusiastically supported by the American Petroleum Institute and the petroleum industry as a whole. A special staff, under the expert direction of noted specialists, devoted their entire work of at least *six* years to collection, selection, critical evaluation, and calculation of numerous properties of hydrocarbons. With such an approach to the subject, naturally the most valuable and successful results were obtained.

To illustrate the completeness and thoroughness of this project, it is sufficient to enumerate the basic properties presented in the volume: boiling point and its relation to pressure, refractive index, density, freezing point, molecular volume, molecular refraction, specific refraction, refractivity intercept, specific dispersion, viscosity (absolute and kinematic), heat of vaporization, entropy of vaporization, heat of combustion, heat of formation, free energy of formation, entropy, heat content, heat capacity, and heat of fusion.

Most of the properties are given for all classes of hydrocarbons up to compounds containing 10 carbon atoms in the molecule. Viscosity and thermodynamic data are prescribed for hydrocarbons up to compounds containing 20 carbon atoms in the molecule.

Every worker in the field of hydrocarbons, chemist and engineer alike, will be elated to have at last these valuable data collected in one volume.

Some criticism can be made on the appearance of the book and particularly on the cumbersome method employed in indexing the table of contents. Such a valuable book merits also a better paper and print.

V. I. KOMAREWSKY
Illinois Institute of Technology

The systematic identification of organic compounds: a laboratory manual. (3rd ed.) Ralph L. Shriner and Reynold C. Fuson. New York: John Wiley; London: Chapman & Hall, 1948. Pp. ix + 370. (Illustrated.) $4.00.

"In this edition," according to the author, "recognition is given to the fact that the primary feature of the student's assignment and the wellspring of his interest is the identification of unknown compounds. He is no longer directed to perform numerous practice experiments on solubility and in the use of classification reagents but is advised to carry out such control and practice experiments as are needed, in view of his previous training."

Additional classification reagents are introduced as well as additional procedures for the preparation of derivatives. The melting points of solids and the boiling points of liquid have been included, in parenthesis, in the index, thus saving a considerable amount of time on the part of the student.

The chapter headings are: "Introduction," "The Identification of Unknowns," "Preliminary Examination," "The Determination of Physical Properties," "Qualitative Analysis for the Elements," "The Solubility Classes," "Application of Classification Tests," "The Preparation of Derivatives," "Tables of Derivatives," "The Separation of Mixtures," "The Interpretation of Experimental Data," and "Problems."

The chapters have been both enlarged and rearranged

to improve the teaching value. This book may be considered both as a valuable text and as "one of the indispensable reference books of organic chemistry."

ED. F. DEGERING

Purdue University

Encyclopedia of chemical technology. Vol. I: ***A to Anthrimides.*** Raymond E. Kirk and Donald F. Othmer. (Eds.) New York: Interscience, 1947. Pp. xxiv + 982. (Illustrated.) $20.00.

This is the first volume of a 10-volume encyclopedia dealing with the practice and principles of modern chemical technology. When completed, it will fill a long-felt need for a comprehensive treatise to which professional chemists and chemical engineers may turn for information on the methods used in the American process industries. It is intended for those in universities and other research institutions, as well as for those who are working in industry.

The work is organized as a specialized encyclopedia and is by no means a handbook or series of monographs. The entire field of chemical technology is covered. The first volume contains nearly 100 articles on industrial chemicals and materials, on unit operations and processes of chemical engineering, and on chemical principles. Of these, 35 titles are of major length, including Absorption, Acetic Acid, Acetylene, Acid-Base Systems, Adhesives, Adsorption, Alcohol (Industrial), Alkali and Chlorine Industries, Alkali Metals and Alkali Metal Alloys, Alkaloids, Alkyd Resins, Alloys, Amination by Reduction, Amino Resins and Plastics, Ammonia, Analytical Chemistry, Anthraquinone and Related Quinonoid Dyes, and others.

The arrangement of the subject matter follows a general plan of grouping together topics that are technologically related. Important chemicals are frequently dealt with in articles under their own name, but those which have similar uses are described under a single heading—for example, Abrasives, and Anesthetics. Others may be grouped because of similarity in processing, or as products of an integrated industry (e.g. chlorine, sodium carbonate, and sodium hydroxide). At times this results in some duplication; the manufacture of aniline is described under Amination by Reduction as well as under Aniline. Numerous cross references are provided in the articles, and the individual name of each substance in alphabetical order directs the reader to the proper group title.

The articles on industrial chemicals and materials include sections on physical and chemical properties, methods of manufacture, uses and applications, specifications and standards, and health and safety factors in handling. There are articles on the chemical engineering unit operations, as well as background articles on physical and organic chemistry, metallurgy, and other subjects which serve as important references in process principles.

The format of the book is pleasing. Subject headings and subheadings are clear, and the quality of the paper and printing are excellent. The volume is strongly bound. These qualities are especially important in an encyclopedia which will have hard usage in libraries. The editors have been fortunate in selecting outstanding authorities to write the articles in this volume. The remaining volumes, which are to be published at the rate of two to three each year, will be anticipated by a host of users.

H. F. JOHNSTONE

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The sulfonamides and allied compounds. Elmore H. Northey. (American Chemical Society Monograph Series.) New York: Reinhold, 1948. Pp. xxvii + 660. $15.00.

Dr. Northey's book is an outgrowth of a review prepared and presented at the Symposium on Chemotherapy held at Gibson Island, Maryland, in 1939, under the sponsorship of the Section on Chemistry of the AAAS. "The original review was enlarged and revised under the sponsorship of the Division of Medicinal Chemistry of the American Chemical Society and was published in Chemical Reviews, 27, 85–196 (1940)." Since then, the revolutionary achievements of the sulfonamides in the treatment and control of human and animal diseases have been recognized by everyone. However, the extent of the contributions of the chemists and experimental scientists in the development of this field may not be fully appreciated. Dr. Northey has revised and amplified his previous publication into the present monograph, which emphasizes the "chemical side of the new chemotherapy."

The book opens with a chapter on the "History of Bacterial Chemotherapy," which reviews the development of antibacterial agents, including the discovery of the active azo dyes by the German investigators and the establishment of the role of sulfanilamide in their therapeutic activity by the French. A chapter on "Nomenclature, Classification and Synthesis of Sulfonamide Derivatives" follows. Three chapters are devoted to the classification of the chemical structure and chemotherapeutic activities of sulfanilamide derivatives, one to sulfones and one to compounds related to the sulfones. These chapters, covering over 5,000 compounds, include a brief review of the chemistry and pharmacology of each series, while the tables provide data on structure, melting range, activities, and references to information on other important properties of the drugs. This compilation of data on the sulfonamides and related compounds is of immeasurable value as a reference source for those interested in keeping up with the developments in this field.

A series of 5 chapters on the evaluation of chemotherapeutic activity, relationship of structure to activity, pharmacology, mechanism of action, and evaluation cover the biological phase of the problem. Harold J. White, bacteriologist at the Stamford Research Laboratories of the American Cyanamid Company, wrote the chapter on the "Experimental Evaluation of Chemotherapeutic Activity," and in this he describes *in vitro* and *in vivo* methods for the testing of new chemotherapeutic agents and summarizes in tabular form the experimental results as reported by different investigators on 23 of the better-

known sulfa drugs. The significance and importance of absorption, excretion, distribution, alteration, and toxicity studies in animals of the chemotherapeutic agents is emphasized by J. T. Litchfield, Jr., in the chapter covering the pharmacology of these compounds. In the chapter on "Relationship of Structure to Chemotherapeutic Activity," Dr. Northey has attempted to "point out some of the generalizations or inferences which may be drawn from the mass of often-conflicting data" reported. Benjamin W. Corey, director of Lederle Laboratories Division of the American Cyanamid Company, reviewed and edited the summary on the medical use and application of these drugs, which "is not intended as a therapeutic guide but as a research tool." A critical analysis of the various theories of the mechanism of action of the sulfonamides and their contributions to the developments in this field is admirably covered in Chapter XI.

The last section of the book contains appendices covering the key to activities, organisms or diseases, and trade names for sulfanilamide, its derivatives, and related compounds.

The reference list contains 2,668 references, of which about 600 are largely chemical.

The book is well bound and printed, and only a few errors were noted by the reviewer. In the 5 chapters dealing with the classification of the compounds, grouping of all the tables at the end of each chapter presents some inconvenience in referring to these while following the text. However, Dr. Northey has presented a wealth of information in an interesting manner, and his book should be on the "must" list as a ready reference for those biologists, pharmacologists, clinicians, chemists, and others engaged in, or wishing to undertake or become informed of, research on the sulfonamides.

MAURICE L. MOORE
Smith, Kline & French Laboratories, Philadelphia

The Rb factor in the clinic and the laboratory. Joseph M. Hill and William Dameshek. (Eds.) New York: Grune & Stratton, 1948. Pp. 192. (Illustrated.) $4.25.

This special issue of *Blood, The Journal of Hematology,* contains articles on the Rh factor by 15 contributors. The papers were originally read at the International Hematology and Rh Conference in Dallas and Mexico City.

Following a short introduction by Dameshek, Levine presents an over-all summary of the history and significance of the Rh factor. Papers on the history of Rh seldom agree as to details and often show a deplorable tendency to personal bias. Unfortunately, the present summary is not entirely free from such bias. It does, however, cover the essential facts of the general Rh picture and sets the stage for the subsequent presentations.

The second paper, by Race of Great Britain, contains an account of the activities of the British workers from 1943 to 1947, culminating in the formulation and testing of the Fisher scheme of allelic arrangement of the genetic factors. Multiple alleles at the C and D loci are discussed, and the entire genetic picture is reviewed.

A contribution by Dameshek on hemolytic mechanisms follows. The physiologic principles of red cell destruction are reviewed, and hemolysins, agglutinins, erythrostasis, splenic activity, and chemical and physical factors are discussed.

Guzman of Mexico presents a short summary of his researches on the nucleolar content of blood cells, involving studies on the volumetric, morphological, and structural characteristics of nucleoli.

The fifth paper is a report by Witebsky on the interrelationship between the Rh system and the A B system, centered largely around an instance of the production by the mother of an erythroblastotic baby of an anti-A antibody of the blocking type, which served as a sensitive diagnostic serum for differentiating the subgroups of group A.

Hill, Haberman, and Jones offer a provocative paper on hemolytic Rh-immune globulins in which they present evidence for a third order of antibodies. Their classification of antibodies would include classical agglutinins (specific adsorption with subsequent agglutination), blocking antibodies (specific adsorption with saturation of the antigen and no agglutination), and cryptagglutinoids (specific adsorption without evident saturation of the antigen and without agglutination).

Muirhead, Haley, Haberman, and Hill, in the seventh paper, present a long and complete discussion of the management of acute renal insufficiency due to incompatible transfusion, based on 28,630 blood transfusions over a period of 8 years.

Davidsohn discusses the study of Rh antibodies in the bloods of 73 mothers of babies with fetal erythroblastosis. Correlation of the results with clinical findings indicated that blocking antibodies are present in 85% of mothers of babies with hydrops or stillborn, but in only 9% of mothers of babies with icterus gravis. Predominance of saline agglutinins favored survial.

The next paper, by Chown, presents some anomalous results of Rh sensitization, including instances in which normal Rh-positive children succeeded diseased children and in which normal children were born to mothers with anti-Rh antibodies in their blood.

The possible role of the A and B factors in erythroblastosis is discussed by Orozco of Mexico, and evidence for the importance of these factors in the production of the disease is presented.

Wallerstein outlines the basic pathology of erythroblastosis and considers in detail the indications for, and treatment by, blood transfusion.

A report of the after-luncheon discussion, at which a number of practical problems were considered, and the banquet address by Guerola of Mexico, on the history of blood transfusion in Mexico, constitute the last two sections of the volume.

Although there are certain regrettable commissions among the contributors to the volume, it stands in general as a fairly complete, up-to-date summary of the many facets of the important problem of blood incompatibility.

LAURENCE H. SNYDER
The University of Oklahoma

Tuberculosis: a discussion of phthisiogenesis, immunology, pathologic physiology, diagnosis, and treatment. Francis Marion Pottenger. St. Louis, Mo.: C. V. Mosby, 1948. Pp. 597. (Illustrated.) $12.00.

This volume is a timely synthesis of current clinical knowledge on human tuberculosis, a harmonious conception built from accepted facts and plausible hypotheses.

The author's vast experience as a professor of medicine and a phthisiologist backed with 50 years of practice shows in this work through a clever condensation, in well-balanced chapters, of this varied and extensive subject, through a great consistency of thought and a shrewd application of scientific criticism. Also noteworthy is the lucidity of presentation and style. Those are several reasons why the reading of the book is captivating and highly suggestive of fertile ideas and research topics. A few recurring statements serve the evident purpose of focusing attention on essential facts.

The author rightly stresses the necessity of avoiding fruitless conjectures as well as reinvestigating those theories about to be reckoned as dogmas.

He lingers neither on historical backgrounds nor on past experimental works. However, on the one hand, a well-informed reader feels sure that every line relies upon the soundest of fundamental knowledge, both clinical and experimental; on the other hand, he who is less acquainted with the field retains the impression of having assimilated most of the essential basic notions because Dr. Pottenger has so cleverly impregnated his interpretation of clinical findings with accepted experimental conclusions.

The author is to be praised for insisting upon phthisiogenesis. Too many physicians take to phthisiology as a specialty without sufficient knowledge of that aspect. It is the basis of any reliable clinical or epidemiological study. Three chapters are given to reinfection with its specific and nonspecific factors. Whether reinfections are endogenous or exogenous is judiciously discussed, and the grounds from which the author explains the frequency of endogenous reinfections oblige to no mere thinking and outgrow a plain clinical interest: the very strategy of the fight against tuberculosis is here at stake.

To be noted are two valuable chapters on the visceral neurology of pulmonary tuberculosis and a short one on vaccination. Vaccination with nonvirulent bacilli would have two advantages, one positive, the other negative. "It would protect the host from infection with virulent bacilli but it would not furnish a focus of virulent bacilli from which metastases would take place and cause reinfection tuberculosis."

Every chapter ends with an abundant basic bibliography, mostly clinical. Concerning vaccination with BCG, it seems that the author, in view of present-day trends, could have given a well-deserved importance to an angle of antituberculous prophylaxis that enjoys so increasing an interest.

We would recommend this book to the phthisiologist as a vade mecum; to the practicing physician as an easily readable treatise comprising the sum total of today's fundamental knowledge along with the most modern clinical guiding principles on tuberculosis; to the research worker and to the epidemiologist as an almost complete source of physiological, pathological, and clinical data, absolutely necessary for intelligently carrying on research on tuberculosis or organizing the fight against it with logical and coordinate planning. Such an important subject must not suffer from departmentalization.

The magnitude of the problem calls for an equal magnitude in the study of the disease and the fight against it. A synthesis like Dr. Pottenger's is to be acknowledged as an invaluable contribution to that end.

ARMAND FRAPPIER
University of Montreal

Animal genetics and medicine. Hans Gruneberg. New York-London: Paul B. Hoeber, 1947. Pp. xii + 296. (Illustrated.) $5.50.

Written by an English scientist well trained in fundamental genetics and actively contributing to genetic research, this book is an attempt to aid contact and collaboration between animal genetics and medicine.

Two primary aims have been the demonstration that there exists a vast array of inherited conditions in animals, some of which are closely akin to human diseases, and all of which present problems the solution of which will aid directly or indirectly in the understanding of human diseases; and the demonstration that the etiology of these conditions can be approached with methods which would be impracticable in man.

The material concerning the value of inbred animals and the importance of animals over human beings in the study of disease is excellent and easily digested. When Dr. Gruneberg writes about genes (Chap. III), the book becomes fairly heavy for a medical man, and it is doubtful if an American doctor, combining research with practice, as many do, would go much further through the book.

The study of inherited diseases in animals is a new branch of medical science. The author hopes to convince a few more people of the value of a new tool for etiological studies. It seems unfortunate that material from a field such as cancer research, where the value of the animal in etiological studies is well recognized, was omitted.

The geneticist will find the book interesting and excellent.

GEORGE W. WOOLLEY
Roscoe B. Jackson Memorial Laboratory

Histopathologic technic. R. D. Lillie. Philadelphia-Toronto: Blakiston, 1948. Pp. xi + 300. $4.75.

Histopathologic technic is commendably not an encyclopedic compilation of histologic and cytologic technical methods. It is devoted, for the most part, to descriptions of methods which in the author's laboratory have been found to give consistent results. The complexity of tissues and the influences of diverse physiological states in themselves make fixing and staining procedures behave capriciously. Such variables cannot be adequately controlled; however, the author has striven to include those methods which depend for constancy of results on con-

trollable factors, *i.e.* time, hydrogen ion concentration, temperature, purity and concentration of reagents, stains.

The subject is covered in 21 sections, as follows: Microscopy; Equipment; Fixation; Decalcification; Sectioning; Stains and Staining; General Staining and Mounting Procedures; General Oversight Methods; Nuclear Stains; Cytoplasmic Granules; Enzymes; Endogenous Pigments; Exogenous Pigments and Minerals; Various Cell Products; Fats and Lipoids; Connective Tissue Fibers; Fibrin, Bacteria, Protozoa, and Other Parasites; Glia and Nerve Cells and Fibers; Hard Tissues; Various Special Procedures; and Buffers and Buffer Tables. The author throughout carefully specifies the Color Index Numbers of the stains and also the reference standards of purity of essential chemical reagents otherwise called for in his methods. A very useful series of tables for the preparation of buffer solutions is included. In so far as is possible, the rationale for procedures and the modification of old methods is indicated. The book is made a practical and workably integrated unit by virtue of many cross references. It is excellently indexed.

This treatise on histopathologic technic will satisfy a need long felt by many pathologists and histologists alike.

KENNETH M. RICHTER
University of Oklahoma School of Medicine

Annual review of microbiology. (Vol. 1.) C. E. Clifton. (Ed.) Stanford, Calif.: Annual Reviews, 1947. Pp. vii + 404. $6.00.

This first volume is an attempt to provide a résumé of current research in the field of microbiology. It appears to be a critical evaluation of a wide range of subject matter including viruses, rickettsiae, bacteria, fungi, and protozoa, as well as some of their biological processes.

It is commendable that an annual review of this field has been started. Researchers now may have the opportunity to obtain a broad, comprehensive viewpoint in the working relationships of the various organisms.

There are 17 different subjects represented: Morphology and Cytology of Protozoa, Antigenic Variation in Protozoa and Bacteria, Life Cycle of Malarial Parasites, Variation in Phytopathogenic Fungi, Variation in Phytopathogenic Viruses, Some Aspects of the Problem of Growth Factors for Protozoa, Bacterial Metabolism, Nitrogen Metabolism, Industrial Fermentations, Quaternary Ammonium Compounds, Antibiotics, Chemotherapeutic Agents, Immunochemistry, Some Aspects of Active Immunization, Medical and Epidemiological Aspects of Enteric Infection, The Rickettsiae, and Respiratory Viruses.

Each of the 17 sections in this book is written by a contributor or contributors who have had personal experience with the particular subject. The editors have done an excellent job in their choice of contributors. The various authors have done exceptionally well with their assignments although somewhat handicapped for the sake of brevity. Each section is well documented by a good working bibliography. This will be extremely helpful for those who desire to obtain more information concerning the subject.

The volume concludes with an author and subject index totaling approximately 20 pages. Students and workers interested in the various aspects of microbiology will find this book a helpful and useful addition to their library.

BANNER BILL MORGAN
University of Wisconsin

Kampen mot Ogräset, 1935–1946. ("Weed control experiments.") Hugo Osvald. (Ed.) (Publications from the Institute of Plant Husbandry, Royal Agricultural College of Sweden, No. 2.) Uppsala: Almquist & Wiksells, 1947. Pp. 318. (Illustrated.) 25 kr.

This volume of 18 papers presents the results of 12 years of weed control research at the Royal Agricultural College of Sweden. The type and scope of these investigations are worth noting since weed research programs are now expanding rapidly along many lines. All of the papers are of high technical quality, and space permits a review of only a limited number of them—principally those concerned with weed biology. Although Swedish is the language used, excellent English summaries are included, and all illustrations and tabular material are provided with English translations.

Two papers on germination biology, by von Hofsten and by Kolk, are here considered together. These concern after-ripening, storage, and the influence of light (especially different daylight intensities), temperature, and moisture on the germination of weed species in 21 genera, many of which are common weeds in this country. Freshly harvested seeds of *Matricaria inodora* germinated well in light, but, as they became older, the germinative capacity in darkness increased. Old seeds of *Thlaspi arvense* germinated only under fluctuating temperatures. Light retarded the germination of both light brown and dark brown seeds of *Sinapis* (*Brassica*) *arvensis* when they were exposed to fluctuating temperatures. On the soil surface the light brown seeds germinated less well than the dark brown. Seeds of *Avena fatua* germinated at a temperature as low as 2° C. Freshly harvested seeds of *Chenopodium album* did not germinate at all, while older seeds did germinate, and about 5 or 6 times as well in darkness as in light.

Kolk notes that the effect of light is modified by the age of the seeds. Four groups are recognized: (1) species in which young seeds germinate well in bright daylight and old seeds well in weak daylight (e.g. *Cirsium arvense*), (2) species that germinate well in weak daylight (e.g. *Capsella bursa-pastoris*), (3) species that germinate well in weak daylight or darkness (e.g. *Stellaria media*), and (4) species whose young seeds are unaffected by light, while older seeds germinate well in weak daylight (e.g. *Agrostemma Githago*). Varying temperatures (between 5° and 22° C) favor the germination of most of the species studied (e.g. *Sinapis arvensis*) as compared with constant temperatures (20°–22° C). For most of the species the optimum of germination, in weak daylight as well as in darkness, was found at a water content in the substrate (sandy soil rich in humus) of 60% of the maximum water capacity. At 30% of the maximum

water capacity seeds of species of *Centaurea, Galium, Sinapis,* and *Stellaria* germinate quite well. Studies of germination at various depths led to the recognition of three classes: (1) species that germinate well on the soil surface or at a shallow seeding depth, but not when covered more deeply than 2 cm (e.g. *Stellaria media*), (2) species that germinate better at a shallow seeding depth, but do germinate when covered more deeply than 2 cm (e.g. *Cirsium arvense*), and (3) species that germinate on the surface, at a shallow depth, and when covered more deeply than 2 cm (e.g. *Agrostemma Githago*).

A soil seed-population study of *Sinapis arvensis* by von Hofsten revealed an average of 267 living seeds for each 16.8 liters of soil (0–30 cm in depth), or 4,445 seeds/m² at that depth for 9 different samples, the largest number of seeds occurring in the depth range of 15–25 cm.

A remarkable example of the "equipment of plants in the struggle for space" is provided in the observations of Osvald on the poor germination and development of rape (*Brassica napus* and *B. rapa*) in patches of quack grass (*Agropyron repens*). Toxic root exudates were suspected. He cites the early work of Whitney (1904), and Livingston (1905, 1907), of the USDA, on the presence of toxins in unproductive soils and also notes that, with the discovery of the effects of penicillin, streptomycin, and phytohormones, the toxin theory has attracted revived interest. The substance extracted from finely ground dried stolons and roots is soluble in water and in alcohol. Tests indicate an acid, and the effects on germination resemble those of the growth substances. More than twice as high a concentration of the extract is required for the total inhibition of oat seeds (50%) than that of rape (20%). At moderate to high concentrations of the extract, mold fungi, *Mucor, Penicillium,* and others, were favored, but at still higher concentrations mold growth is retarded. Mold fungi grow at much higher concentrations than do oats. Seeds prevented from germinating by the toxin often succumbed to the molds. Osvald advances an hypothesis with far-reaching applications: Resistance of certain species to hormone derivatives may be due to the fact that "they . . . produce similar substances (or substances with similar effect) in fairly large quantities, and . . . are accustomed to these. Susceptible plants . . . probably produce growth substances in small quantities (or other types of growth substances)." By this hypothesis he notes that many phenomena of plant growth and grouping of natural vegetation may be explained, as "the ability of many grasses to supersede clover, the detrimental effect of grasses on fruit trees, and the inability of many wild species in open vegetation (for instance, in mountains and along shores) to compete with grasses, even if these do not form a close stand."

Three papers by Åberg, Schwanbom, and Wiklander are concerned with the effects of sodium chlorate on perennial weeds and on weed seeds in the soil. Osvald, von Hofsten, and Persson have an extensive study on preplanting soil treatments with calcium cyanamide in grain crops. Von Hofsten writes on control methods involving stubble cultivation and surface accumulation of weed seeds, on control of field thistle, and the use of herbicides on annual weeds. Åberg has a survey of weed-control work in the United States. Osvald, Denward, and Åberg have three articles on hormone derivatives in weed control. The editor, Hugo Osvald, closes the volume with a survey of present and future weed-control methods. Included here is an excellent tabulation (with a unique rating system) of the susceptibility of Swedish cultivated plants (64 spp.), weeds (90 spp.), and ligneous plants (20 spp.) to applications of sodium chlorate, calcium cyanamide, copper sulfate, sulfuric acid, dinitro-ortho-cresol, and hormone derivatives.

LAWRENCE J. KING
Boyce Thompson Institute for Plant Research, Inc.

The essentials of plant biology. Frank D. Kern. New York-London: Harper, 1947. Pp. vii + 440. (Illustrated.) $4.00.

This new textbook is designed for a one-semester course in elementary botany. The book employs a functional approach, yet presents basic botanical concepts in a progressive sequence which enables beginning students to obtain readily a clear understanding of the unity of plant life. The text comprises two major parts: the manifestation of life, stressing individual maintenance, and the perpetuation of life, covering various aspects of racial preservation. The overview of the plant kingdom is presented as a 50-page supplement on the great groups of plants. Attention throughout is centered upon plant activities and interpretation of life phenomena. The broad concepts of plant life bearing on human culture are expertly merged with the role of plants in contemporary affairs.

The book is profusely illustrated with 260 figures, most of which are new and especially well adapted to the full development of textual concepts. Several excellent full-page color plates contribute substantially to clarity of detail. The cuts are of uniformly high quality both in choice of material and excellence of reproduction. The format and headings are material aids to the organization of subject matter, and the author's style of presentation provides unusual clarity and interest for student readers. The author has achieved readability without sacrifice of scientific accuracy by minimizing the use of technical terminology and introducing it with care. Student interest has been attained by good organization, choice of interesting content, good illustrations, and diversity of references to practical applications of principles. The book is quite different from most of its kind, and for a one-semester text it gives the reader an exceptionally thorough grasp of plant science and its importance in modern life. The 16-page index is very complete and greatly facilitates reference use of the text.

The author has drawn ingeniously upon his rich first-hand acquaintance with the world flora and his long experience in presentation of the various disciplines of plant science. The excellence of content and style of the book will appeal to students and instructors.

W. F. LOEHWING
State University of Iowa

The genetics of garden plants. (3rd ed.) M. B. Crane and W. J. C. Lawrence. Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1947. Pp. xvii + 299. (Illustrated.) $3.50.

The first edition of *The genetics of garden plants* was issued in 1934 and the second in 1938. This new edition has 11 additional pages of text and one new chapter which assembles the discussion of zenia and metazenia. Otherwise, the scope and the topics treated are the same as in the second edition. There is some revision to include information obtained in the extensive researches of the years since 1938.

In the words of the authors, "The aim of this book is twofold: first, to give an introduction to the essential principles of genetics and cytology; and secondly, to give an account of recent results in relation to horticulture" and "to describe principles as simply as the technicalities of our subject will allow." The authors have been highly successful in doing all this. They present information of both scientific and practical value in a manner that will interest a wide circle of persons who grow plants, such as gardeners, orchardists, and seedsmen, as well as the more technically trained horticulturists and plant breeders. Many of the plants that are discussed are commonly grown as ornamentals or as vegetable and fruit crops. Many of the features of their status and behavior may be observed. The authors correlate these features of character and behavior with the physical structures of the mechanism of heredity as these are revealed by the microscope and by experimental studies. The information given has a basis in facts that are of interest and often of practical value. Of the topics treated, mention may be made of the following: the basis and mechanisms of heredity as revealed by the behavior of chromosomes and genes; the origin, nature, and value of polyploidy; the chemical and genetical basis of flower color; the explanation of bud sports and chimeras, which have always been puzzling to the amateur gardener; the types of sterility in plants and their relations to the production of fruits; the histories of such commonly cultivated plants as potato, tomato, strawberry, sweet-pea and dahlia; and a survey of the means by which new and improved forms of plants are obtained.

In its particular scope and method of treatment this volume has no counterpart.

A. B. Stout

The New York Botanical Garden

Experimental embryology in the Netherlands, 1940-1945. M. W. Woerdeman and Chr. P. Raven. New York-Amsterdam: Elsevier, 1946. Pp. xi + 132. (Illustrated.) $2.50.

This volume is one of a series of monographs on the progress of research in Holland during the war. It is a survey of the investigations of Woerdeman and his associates, Van Deth, Hampe, Trampusch, Ten Cate, Damstra, and Miss Huybers, at Amsterdam, and of Raven and his associates, Bretschneider, Nieuwkoop, Van de Kamer, Miss Exalto, Kloek, Klomp, Kloos, Lever, and Van Nieuwenhoven, at Utrecht. As the authors explain, their two laboratories were the only ones in Holland in which any systematic work in experimental embryology was done during the war years.

The investigations reported here cover many topics. They include experiments, with amphibian eggs, on: determination of lens, urogenital organs, neural crest, pineal body, lateral plate, germ cells, genital ridge, and polarity of epidermal and neural ectoderm; heterotransplantation of mouth ectoderm; induction of dorsal fin, ear, and limb; specificity of induction by different parts of chordamesoderm; effect of X-rays, trivalent arsenic, and carcinogenic hydrocarbons; respiration in relation to temperature and developmental stage; decapsulation of eggs with trypsin. A few experiments with chick embryos relate to the development of the germ cells, gonads, and their ducts. The pond snail, *Limnaea stagnalis,* is the subject of a rather comprehensive investigation, including studies on egg-laying; physical and cytochemical changes during oogenesis, cleavage, and early development; effects of centrifugation and of treatment with LiCl and with NaSCN. Some of the work has been published in detail in various journals.

Brief mention is made of the difficulties involved in attempting research during the war. Despite these difficulties, it is quite evident from this survey that the high caliber of work for which these laboratories are noted was maintained and that the experiments were performed in many cases with the usual thoroughness.

To illustrate further the nature of the problems under investigation, mention may be made here of a few of the general conclusions that are presented. From his studies on polarity Woerdeman concludes that determination is a gradual process and that the various manifestations of polarity in a particular tissue (e.g. direction of ciliary beat, axes of ear vesicle, direction of outgrowth of axon, etc.) are determined independently by the operation of different causative agents. The results of experiments on inductive capacity of medial and lateral parts of the archenteric roof are considered by Raven to support the view of a single "evocator" substance, present in high concentration medially and decreasing laterally. For neural plate induction a high concentration would be required, while neural crest would be induced by lower concentrations.

Albert Tyler

California Institute of Technology

The epithelia of woman's reproductive organs: a correlative study of cyclic changes. George N. Papanicolaou, Herbert F. Traut, and Andrew A. Marchetti. New York: Commonwealth Fund, 1948. Pp. vi + 53. (Illustrated.) $10.00.

In 1917 Stockard and Papanicolaou published their observations on the sex cycle of the guinea pig. Throughout the intervening 30 years, Papanicolaou has continued to devote his talent to amplifying the innumerable connotations which can be developed from this basis. The human vaginal smear has become a method of obtaining an insight to the ovarian function. In 1928 he pointed out that desquamated cancer cells can be recognized in the

vaginal fluid. In 1943 Papanicolaou and Traut published a monograph on *Diagnosis of uterine cancer by the vaginal smear*, based on the study of over 3,000 women.

The present monograph, written with Traut and Marchetti and published with the aid of the Commonwealth Fund, chronologically really should antedate the others, as it represents the fundamental cytology of the epithelia of the female generative tract with particular attention to the cyclical changes produced by the ovarian cycle. The text is largely a commentary on the 22 admirable colored plates which show the follicle, corpus luteum, tubal, endometrial, endocervical, and vaginal epithelia.

It is rather confusing that in Chapter III, day one for the human menstrual cycle corresponds to the day of ovulation, while on the final colored plate it is assigned to the first day of menstruation. Based on cytologic criteria, the corpus luteum begins to regress by the 9th–11th day and corpus luteum of pregnancy, by the 120th day. The maxima of development of tubal, endometrial, and vaginal epithelia are described.

This monograph is an atlas and source book which should prove of utmost help to gynecological pathologists. It contains material which previously had to be searched for in the widely scattered literature.

ROBERT T. FRANK

1035 Park Avenue, New York City

The brain of the tiger salamander (Ambystoma tigrinum). C. Judson Herrick. Chicago: Univ. Chicago Press, 1948. Pp. vi + 409. (Illustrated.) $5.00.

This monumental work represents the culmination of 50 years of labor on the nervous systems of vertebrates. The author has not only amassed an enormous amount of data on the details of neurological structure in the salamander, but he has also laid a broad foundation for the comprehensive understanding of all vertebrate brains, with special emphasis on the origins of structural features and functional capacities of the human brain, and the general principles of their evolutionary development.

Because of its typical generalized, primitive, vertebrate brain, the salamander has lent itself admirably to this study, and the fruitfulness of Herrick's concentration on this form, as testified by the present volume, is ample evidence of the wisdom of his choice.

The book has 300 pages of description and discussion and is divided into two parts which can be read independently of each other. Part I (120 pp.) is devoted to a general description of the brain of the salamander, together with several chapters on physiological analyses and interpretations, and a final chapter on general principles of embryologic and phylogenetic morphogenesis. This section is designed to give biologists, clinicians, and psychologists an outline of the plan of organization of a generalized vertebrate brain and some insight into the physiological principles exemplified in its action.

The second section (180 pp.) deals with the intricate structure of the salamander brain and presents the detailed evidence upon which the first part is based. It is drawn from the author's many previous papers as well as from considerable new material. Altogether, it is an invaluable reference for specialists interested in either comparative neurology or experimental neurophysiology.

The descriptive material is followed by 11 pages of bibliography and 70 pages of illustrations, the latter consisting of surface views and diagrams showing the internal architecture of the salamander brain, together with complete explanatory notes.

Dr. Herrick's lucid style, obvious enthusiasm, and broad perception give this specialized text, particularly Part I, the rare quality of being both interesting and intriguing reading. The author has performed a signal service in so ably presenting the results of his life-long quest.

WALTER A. STULTZ

University of Vermont College of Medicine

The neocortex of Macaca mulatta. Gerhardt von Bonin and Percival Bailey. (Illinois Monographs in the Medical Sciences, Vol. V, No. 4.) Urbana: Univ. Illinois Press, 1947. Pp. xi + 163. (Illustrated.) $3.00.

This monograph presents a greatly needed study of the cytoarchitectonic structure of the neocortex of *Macaca mulatta*. The authors describe the fissural pattern of the brain, the cortical architectural types, and their surface distribution; they survey the fields by serial sections and discuss the interrelations of cortical areas. Von Economo and Koskinas' nomenclature is used. A brain map in color, numerous drawings, and excellent photomicrographs illustrate the work.

The main chapters of the book are devoted to description of cortical fields and to critical discussion of the work of earlier authors. The criticism makes stimulating reading, but it does not always appear quite fair, since a number of apparent discrepancies, e.g. in the frontal region, seem to result from differences of interpretation rather than from essentially different findings. As regards whole cortical regions, the divisions suggested by the authors actually are similar to those of Brodmann, but the more detailed characterizations are frequently materially different.

Although it is emphasized that cortical fields often fade inconspicuously into one another, the morphological characteristics as a rule are described rather rigidly as if the fields were uniform. Variability within a cortical sector, if discussed at all, usually is mentioned casually in relation to some specific point the authors wish to make. This treatment of the material may cause some difficulty in understanding the significance of variants which are considered constant and even more difficulty in understanding why the authors hesitate to grant clear status to a number of variants which they describe and discuss. In addition, it is sometimes hard to appreciate in photomicrographs the structural differences in different sectors of the same variant, since it is not always sufficiently clear which variations are considered random and which constant. The problem of distinguishing random and constant variability, however, is of great importance. The authors reject the approach of the Vogts and numerous other workers who recognize as separate fields cortical sectors which show constant, though slight,

structural differences. While the view of the Vogts may be opposed by a variety of arguments and although the view favored by the authors appears more practical in relation to certain functional considerations, it seems unsound to disregard altogether the vast amount of evidence presented by the Vogts and their adherents unless it can be shown that their finer subdivisions are mere random variations. This, however, seems quite improbable. If, on the other hand, a cortical field varies in a constant manner, then, regardless of whether such a variability is considered a characteristic of the field or is expressed by further subdivisions, as the Vogts propose, the fact itself remains, and such a gradient of morphological change is likely to be functionally more significant than the authors are willing to admit.

Despite these difficulties, the book will be of great value for anyone who wishes to familiarize himself with the cytoarchitectonics of the macaque's cortex, and every worker interested in the experimental study of this brain will find it indispensable.

JERZY E. ROSE

Johns Hopkins University

The ways of fishes. Leonard P. Schultz (with Edith M. Stern). New York: D. Van Nostrand, 1948. Pp. xii + 264. (Illustrated.) $4.00.

The purpose of this book is to share with the uninitiated a little of the enjoyment which ichthyologists have in finding out the very diverse and often surprising or impressive manner of life of different fishes.

Simply and enthusiastically written, it is well qualified to interest one in the subject. Especially to be commended to the reader's attention are passages descriptive of the author's personal experiences with fishes in various parts of the world, and those of his friend and colleague, the late Hugh M. Smith.

Sound and sight, locomotion and migration, feeding habits, electric powers and luminescence, association with other animals, breeding habits of fishes, etc. are discussed. Size and growth are considered in a chapter entitled "Giants and Dwarfs," where we also find a method for estimating the weight of a fish from its length. But the mathematics on which this is based are obscure, and we do not believe that any method which does not also take the girth into consideration will prove satisfactory. There are special chapters on fishes dangerous to man (possibly overdramatized), controllable by man, and aquarium fishes.

No attempt is made, however, to give a comprehensive picture of the behavior of fishes, of which there are an estimated 40,000 different kinds, ranging in length, when adult, from ⅓ inch to more than 45 feet and inhabiting seas, lakes, rivers, and torrents from high altitudes in the mountains to the depths of the ocean, and from the North Polar Sea to the edge of the Antarctic Continent. It is also true that the ways of any particular fish are complex, often obscure. Descriptions of them here are frequently, of necessity, brief and unqualified. It follows that some of the statements or seeming implications are open to argument, the prerogative of any enthusiastic student of fishes, or fisherman; but it should be born in mind that Dr. Schultz (who is curator of fishes at the Smithsonian Institution) is one of our soundest and most experienced of the former, and that his opinions are always worth consideration. Hence, this book as a whole, not only an appended classification of fishes, will have reference value on a serious naturalist's shelf as well as giving pleasure to the lay reader.

J. T. NICHOLS

The American Museum of Natural History

Animals alive. Austin H. Clark. Toronto-New York-London: D. Van Nostrand, 1948. Pp. viii + 472. (Illustrated.) $4.00.

From a broad background of personal experience, wide professional contacts, and intimate familiarity with the literature, Dr. Clark has compiled a fascinating volume of simple, direct description and narration. Although it was written for the nonprofessional reader, the technical scientist will here find many fresh facts sandwiched between familiar observations on habits, distribution, and habitats of a vast array of animal forms. Food habits are treated in a particularly appealing manner, as are the chapters devoted to man in his relations to the rest of nature. Domestication of animals as an influence on human culture and on history is dealt with in some detail.

No single basis of organization is followed. Taxonomic groups form the chief framework for treatment in some chapters, although habits, habitats, and distribution provide titles for others. The 38 chapters are grouped by sections as follows: Man and the Animal World; Land Animals; Fresh-Water Animals; and Sea Life.

A great amount of sound natural history is presented without resorting to highly technical terminology. Strictly scientific names are avoided so far as possible, but of necessity the author often refers to genera and other systematic names when no popular or familiar names are available. The editorial omission of initial capitals is an apparent effort to reduce technical names to a popular level. In the index, scientific names are given for all the common names listed. In fact, 38 pages are devoted to a faunal roster from "Aardvark (*Orycteropus capensis*)" to "Zebu (*Bos indicus*)."

The plates are not particularly meaningful, since there is no direct reference to figures in the text. In fact, many of them are not especially well done. Availability of cuts in the Museum files seems to have been the chief basis for selection and inclusion rather than attractiveness and appeal to the general reader.

Intimate and often weird interrelationships of animals are particularly stressed. The past and the present are woven together in considering the balances between animals and their environments. Often, provocative attention is drawn to the upset of balance in nature.

There are few direct references and no literature lists, although works of specialists are often mentioned in intimate personal references.

This book is a distinctively worth-while contribution to a wider general appreciation of "animals alive."

HARLEY J. VAN CLEAVE

University of Illinois, Urbana